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RICHARD BENTLEY, F.S.A.

(*President of the Royal Meteorological Society*, 1905-6)

Frontispiece, Quart. Journ. Roy. Met. Soc. vol. xxxiii. *From a Photograph by Messrs. Elliott & Fry.*

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CONTENTS.

PAGE

The International Congress on Polar Exploration at Brussels, September 1906. By HUGH ROBERT MILL, D.Sc. 1

Optical Society 3

The Rainfall of Africa 4

The Abnormal Weather of the Past Summer and some of its Effects. By WILLIAM MARRIOTT, F.R.Met.Soc., Assistant Secretary. (Twenty-seven Illustrations) 5

The Guildford Storm of August 2, 1906, By Admiral JOHN PEARSE MACLEAR, F.R.G.S., F.R.Met.Soc. (Three Illustrations) . . 41

Climate of the Wheat Area of Central Canada . . . 55

Proceedings at the Ordinary Meeting, November 21, 1906 . . 56

Proceedings at the Ordinary Meeting, December 19, 1906 . . 56

Correspondence and Notes :—

- Lectures on Meteorology 57
- Bureau Central Météorologique, Paris 57
- Upsala Meteorological Observatory 57
- Netherlands Meteorological Institute 57
- Meteorological Essay for the Howard Medal, 1906. The Storm Areas of the Globe. By J. A. P. BLACKBURN . . 57
- Destructive Hailstorm in Bedfordshire, August 2, 1906 . 60
- The Structure of Hailstones. (Three Illustrations) . . 63
- Suggestions to Observers of Hailstones . . . 65
- Hailstorm at Lewisham, June 25, 1652 . . . 65
- Beech Trees and Lightning. By Admiral J. P. MACLEAR . 66
- Blue Hill Meteorological Observatory, Mass., U.S.A. . . 66
- Errors of Absorption Hygrometers 67
- The Insolation of Switzerland 68
- Climate of the Niger Basin 69
- Wellington (New Zealand) and Wind 70
- Effect of Drought in 1906 70
- An Indian Rainfall and its Result 70
- Climate of Hebron 71

PAGE
Recent Publications 73
Meteorological Literature 77
Weather in War-Time. By RICHARD BENTLEY, F.S.A., President. [An Address delivered before the Royal Meteorological Society, January 16, 1907.] (Four Illustrations) . . . 81
Report on the Phenological Observations for 1906. By EDWARD MAWLEY, F.R.Met.Soc., V.M.H. (Plate I. and Two Illustrations) 139
The Alps as a Weather-Parting 164
Meteorology in the Antarctic 164
The Metric System in Meteorology. By RICHARD INWARDS, F.R.A.S., F.R.Met.Soc. (Illustration) 165
A Cape Hailstorm 171
Proceedings at the Ordinary Meeting, January 16, 1907 . . 172
Proceedings at the Annual General Meeting, January 16, 1907 . 172
Proceedings at the Ordinary Meeting, February 20, 1907 . . 178
Correspondence and Notes:—
- Lectures on Meteorology 179
- Meteorological Club 179
- Observations of Upper Clouds in New Zealand. By JOHN ST. C. GUNN, M.B., C.M. 180
- Hailstorm at Charlestown, Natal, October 24, 1906. By THOS. E. ALLERTON. (Illustration) 181
- Evaporation from the Soil. By Col. W. F. BADGLEY . . 182
- Meteorological Work at the Royal Observatory, Greenwich, 1906. By Sir W. H. M. CHRISTIE, F.R.S. 182
- Meteorological Work at the Radcliffe Observatory, Oxford, 1906. By ARTHUR A. RAMBAUT, F.R.S. 184
- Daily Weather Report 184
- Société Astronomique et Météorologique de Port-au-Prince . 185
- Measurement of the Height of Clouds by Reflectors . . 185
- Formation of Hailstones. (Illustration) . . . 186
- Readership in Dynamical Meteorology 188

Recent Publications 188
Meteorological Literature 190
The Exploration of the Air. By Major B. F. S. BADEN-POWELL. [Abstract of a Lecture delivered before the Royal Meteorological Society, March 20, 1907.] (Six Illustrations) . . . 193
Rain-Making Experiments in the Klondike 199
Rainfall of German South-West Africa 200

PAGE
Effects of Wind upon Railways 200
Phenomenal Rainfall in Suva, Fiji, August 8, 1906. By R. L. HOLMES, F.R.Met.Soc. 201
Rainfall at Delanasau, Bua, Fiji, 1906. By R. L. HOLMES . . 205
Temperature around the British Islands in Relation to the Gulf Stream. By RICHARD STRACHAN, F.R.Met.Soc. 207
Effects of the March 1907 Sunshine 211
Mirage in the Desert 212
Hot Sunshine causes a Railway Accident 212
The Hong-Kong Typhoon of September 18, 1906 . . . 212
Weather regarded as a Function of Climate. By L. C. W. BONACINA, F.R.Met.Soc. 213
The Summer and the Autumn of 1768 219
Report of the Council for the Year 1906 221
Balance Sheet 224
Inspection of Stations, 1906 231
Obituary Notices 237
Purchases during the Year 1906 242
Donations received during the Year 1906 242
Ice and its Movements in Baffin Bay 251
Proceedings at the Ordinary Meeting, March 20, 1907 . . 252
Proceedings at the Ordinary Meeting, April 17, 1907 . . . 254
Correspondence and Notes:—
    Investigation of the Upper Atmosphere . . . 254
    Trees and Lightning 255
    Climate of Egypt 257
    Hoar Frost at High Altitudes 261
Meteorological Literature 261
The Best Form of Rain Gauge, with Notes on other Forms. By HUGH ROBERT MILL, D.Sc., President, Director of the British Rainfall Organisation. (Six Illustrations) . . . 265
The Climate of Eritrea, North-East Africa 274
On a Method and Apparatus for Measuring Fog Densities. By JOSEPH W. LOVIBOND, F.R.Met.Soc. (Three Illustrations) . . 275
Note on a Balloon struck by Lightning, April 11, 1907. By Colonel J. E. CAPPER, R.E., C.B., F.R.Met.Soc. (Illustration) . . 279
Kites struck by Lightning, July 10, 1907. By Colonel J. E. CAPPER . 285
Balloon struck by Lightning, July 22, 1907 286

PAGE

The Relation of the Rainfall to the Depth of Water in a Well. By CHARLES P. HOOKER, L.R.C.P., F.R.Met.Soc. (Four Illustrations) . 287

Flickering Lightning 293

Display of Phosphorescence 294

The "Step" Anemometer. By WALTER CHILD. (Two Illustrations) . 295

Ben Nevis Observatory 298

Proceedings at the Ordinary Meeting, May 15, 1907 . . . 299

Proceedings at the Ordinary Meeting, June 19, 1907 . . . 300

Dinner of the Royal Meteorological Society 301

Correspondence and Notes :—

- Meteorology and Agriculture 308
- Official Appointments 309
- Anticyclones as Aids to Long-Distance Forecasts. By Colonel H. E. RAWSON 309
- The Thunderstorms of July 22, 1907, in Ireland . . 310
- Symons Gold Medal, 1908 311

Recent Publications 312

Meteorological Literature 313

Index 317

PLATES.

Frontispiece.	Richard Bentley, F.S.A., President of the Royal Meteorological Society, 1905-1906.
PLATE I.	Map showing Position of the Phenological Stations, 1906.

ERRATA.

Page 38, Footnote. *For* "W and N" *read* "10° W."
,, 39, Line 1. *For* 14·1 *read* 15·6.
,, 39, ,, 2. *For* 15·6 *read* 14·1.

QUARTERLY JOURNAL

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THE INTERNATIONAL CONGRESS ON POLAR EXPLORATION AT BRUSSELS, SEPTEMBER 1906.

BY HUGH ROBERT MILL, D.Sc.

[Read November 21, 1906.]

I HAVE to submit my report as Delegate of the Royal Meteorological Society to this Congress.

Following upon certain resolutions passed at the Colonial Congress at Mons in 1905, the Belgian Government convened an International Congress on Polar Exploration, which met in Brussels from September 7 to 11, 1906, and to which all governments and the leading Scientific Societies in all countries were invited to send representatives.

The governments of the following countries were officially represented —Argentine Republic, Chile, Congo State, Denmark, France, Germany, Holland, Italy, Portugal, Rumania, Russia, Spain, Sweden, and the United States. No official representatives were sent by the British, Norwegian, or Austro-Hungarian governments. The Scientific Societies and especially the Meteorological institutes and polar expeditions of most countries were well represented; but the only British representatives present except myself were Mr. Mossman and Mr. Rudmose Brown of the *Scotia* antarctic expedition; the Royal Meteorological Society was, in fact, the only scientific society in the British Empire which sent a delegate.

Amongst the representatives of foreign polar expeditions, arctic explorers included Mr. H. L. Bridgman of the Peary Relief Expedition, M. Rabot (Spitsbergen), Chevalier Speelman of the Dutch *Willem Barentz* expedition, and M. Tolmatcheff of the Russian arctic survey. Antarctic explorers included as leaders of recent expeditions Dr. Charcot, French; Prof. E. von Drygalski, German; M. de Gerlache, Belgian; and Prof. Nordenskjöld, Swedish. Mr. Mossman and Mr. Rudmose Brown, members of the staff of the Scottish antarctic expedition, MM. Arçtowski, Lecointe, and Dobrowolski of the Belgian antarctic expedition, and Captain Duse of the Swedish antarctic expedition were also present.

Meteorology was specially represented by M. Angot of the Central Meteorological Institute in Paris, M. Bracke (Brussels), Dr. Herrmann of the Deutsche Seewarte in Hamburg, M. Lancaster of the Royal Observatory at Uccle, Prof. Meinardus (Berlin), Prof. Rykatcheff, Director of the St. Petersburg Observatory, and Dr. Van der Stok, formerly of the Batavia Observatory and now of de Bilt.

The Congress was under the presidency of M. Beernaert, Belgian Minister of State, and the meetings were held in a large hall excellently adapted for public functions but not well suited for the general discussion of questions of detail. The object of the gathering was to formulate a scheme of international co-operation in the promotion of polar research, but two circumstances tended to limit its success. The more serious was the official abstention of three of the most important exploring nations—Great Britain, Austria-Hungary, and Norway—thus rendering any decisions less authoritative than they should be. The other was the failure of those responsible for the meeting to realise that foreigners, even those who are fairly proficient in the French language, require a little time to grasp the full meaning of a matter brought up for discussion, and ought to be assisted by an official summary of the speeches in, at least, English and German. At Brussels an extremely skilful interpreter gave the gist of all German or English speeches in French; but that of course was not enough. Another point was the discussion of matters that aroused a certain amount of conflicting national feeling in public, and at times so much heat was engendered that the Brussels press was moved to remind its readers that volcanoes, no less than ice, were characteristic of antarctic regions. It would have added to the harmony of the proceedings if points about which friction could arise had first been discussed privately, and a *modus vivendi* arrived at before any public statements were made. However, all went well in the end, and bearing in mind the exceptional difficulties of the occasion I consider that the deliberations were successful, and that benefit to our knowledge of the polar regions will result from the meeting.

The Congress adopted a constitution and statutes for a permanent International Commission to establish closer scientific relations between polar explorers and to render assistance to polar enterprises, though that assistance is in no case to be financial, nor will the Commission conduct, or act as patron of, any expedition. The Commission is to consist of representatives of all the countries whose inhabitants have conducted polar explorations or taken part in some polar expedition, two acting and two substitute members being appointed for each country either by the government or by learned bodies.

A number of resolutions were passed both in the full meetings and in committees as to desiderata for polar exploration. It is sufficient here to quote those adopted by the Committee on Meteorology, which met under the presidency of M. Angot:—

1. That researches and studies be undertaken in order to construct recording instruments which may be left for longer or shorter periods in uninhabited polar regions.

2. That polar expeditions be furnished with an equipment of kites for the study of the upper air.

3. The Committee desire to see permanent stations installed in the

countries near the poles, wherever it is possible, and to see temporary stations organised at the greatest possible number of points during the continuance of polar expeditions.

4. That polar expeditions should be undertaken in the two hemispheres simultaneously.

5. That during those expeditions meteorological and magnetic observations be made as far as possible exactly in the places where they were made during the international co-operation of 1882-3.

6. That detailed observations of the phenomena of the upper atmosphere be specially recommended to polar expeditions.

7. In order to secure uniformity in the meteorological and magnetic observations, it is desirable that, before their departure, all polar expeditions should enter into communication with the permanent International Meteorological Committee.

As a delegate to the Congress, I must refer in conclusion to the magnificent hospitality which was pressed upon the foreign members by the Belgian Government, the municipalities of Brussels and Antwerp, various scientific societies and institutions, and not least by the Belgian members of the Congress. With a fairly large experience of international gatherings and the social functions which accompany them, I can place the proceedings in Belgium on this occasion second to none in which it has been my good fortune to participate.

Optical Society.

The Optical Society has accepted the offer of Mr. James Aitchison to present prizes to the value of five guineas to encourage junior members of the trade to study the instruments in which they deal, from the point of view of the user's requirements and convenience.

The conditions of the competition are as follow :—

AITCHISON PRIZES.

Five prizes, each of the value of one guinea, will be awarded for essays to be sent in not later than March 1, 1907.

The prizes are open to all under the age of 25 engaged in the Optical industries. Candidates are allowed to select their own subjects in the following groups :—

(*a*) Telescopes.
(*b*) Microscopes.
(*c*) Photographic apparatus.
(*d*) Meteorological instruments.
(*e*) Any other widely used scientific instrument dealt in by opticians.

Candidates will be expected to treat the instrument selected from the user's point of view, and to indicate the various directions in which they can be used in the arts and ordinary processes of trade.

Candidates will also, if they desire, be allowed to select a particular trade or industry, and show how and what scientific instruments can be used in it.

The Society reserves the right to withhold one or more of the prizes if essays of sufficient merit are not sent in.

All essays should be sent to the Hon. Secretary, the Optical Society, 20 Hanover Square, London, W., not later than March 1, 1907.

The Rainfall of Africa.

An attempt to bring together in generalised form the now rapidly accumulating data on the rainfall of Africa has been made by Dr. G. Fraunberger, who has published the resulting rainfall map compiled by him in *Petermann's Mitteilungen* (1906, No. 4). This map deals only with mean annual rainfall, and the important question of seasonal distribution is not touched; but, so far as it goes, the author's work is a valuable step in advance, being based on a careful study of almost all the available data, while, although necessarily still showing only the broader features of rainfall distribution, it enters into considerably more detail than previous attempts in the same direction. With one or two exceptions,[1] Dr. Fraunberger seems acquainted with all the important contributions to the subject that have yet appeared; but though he has embodied a good deal of the previous results, he has throughout made an independent study of the data (which consists of observations from over four hundred stations), and has not hesitated to make corrections where necessary. He has, perhaps, in one or two instances shown too great a confidence in previous work, much of which has necessarily been given in an exceedingly generalised form; and though positive errors have, as already remarked, been eliminated, the map might possibly have been still more valuable had it been based solely on an independent study of the records, though this might have involved more labour. In the accompanying letterpress, Dr. Fraunberger mentions the principal points on which his conclusions differ from those of his predecessors, and also sketches the influence of geographical and other factors in determining the distribution. The actual observations being still far from adequate to afford a complete basis for such a map, it is of course necessary to rely to a certain extent on *a priori* deductions or indirect evidence. Thus the author depends more than once on the facts of vegetation distribution, though these are, perhaps, not quite sufficiently established to be a trustworthy guide. One point of difference from former maps is the smaller annual rainfall assigned to the Air and Tibesti highlands near the southern border of the Sahara, which Dr. Fraunberger, on the basis of Foureau's observations in the former, places at under 200 mm. (8 inches). This is the lowest step in his scale, which ascends in the main map by eleven gradations to an amount of over 4000 mm. (160 inches). The heavy precipitation near the head of the Gulf of Guinea is shown on an inset by a different scale, which distinguishes a maximum, along the small strip of coast west of the Kamerun mountain, of over 10,000 mm. (393 inches). The author points out the influence the rift-valleys (especially in the case of Nyassa and Tanganyika) have on the distribution of rainfall, the eastern sides being markedly drier than the western. He is unable to account for the comparatively small amount of precipitation on the Gold Coast, which still awaits a satisfactory explanation. Some corrections will no doubt be necessitated when the data become more complete. Thus it seems possible, at least, that the rainfall assigned to the Ruwenzori range is too small, being shown as considerably less than that of various other mountainous areas of East Africa. A table gives the observed annual precipitation at about four hundred stations, with a statement of the number of years (still far too few in the majority of cases) during which observations have been made.—*Geographical Journal*, November 1906.

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[1] No account seems to have been taken of Mr. Sutton's work with respect to South African rainfall, or Sir Harry Johnston's rainfall map of Uganda, printed by the Intelligence Division in 1900.

THE ABNORMAL WEATHER OF THE PAST SUMMER AND SOME OF ITS EFFECTS.

By WILLIAM MARRIOTT, F.R.Met.Soc.
Assistant-Secretary.

[Read November 21, 1906.]

THE weather of the summer of 1906 was of such an exceptional character that it has been deemed desirable that some account of it should be presented to the Society.

ROYAL OBSERVATORY
GREENWICH

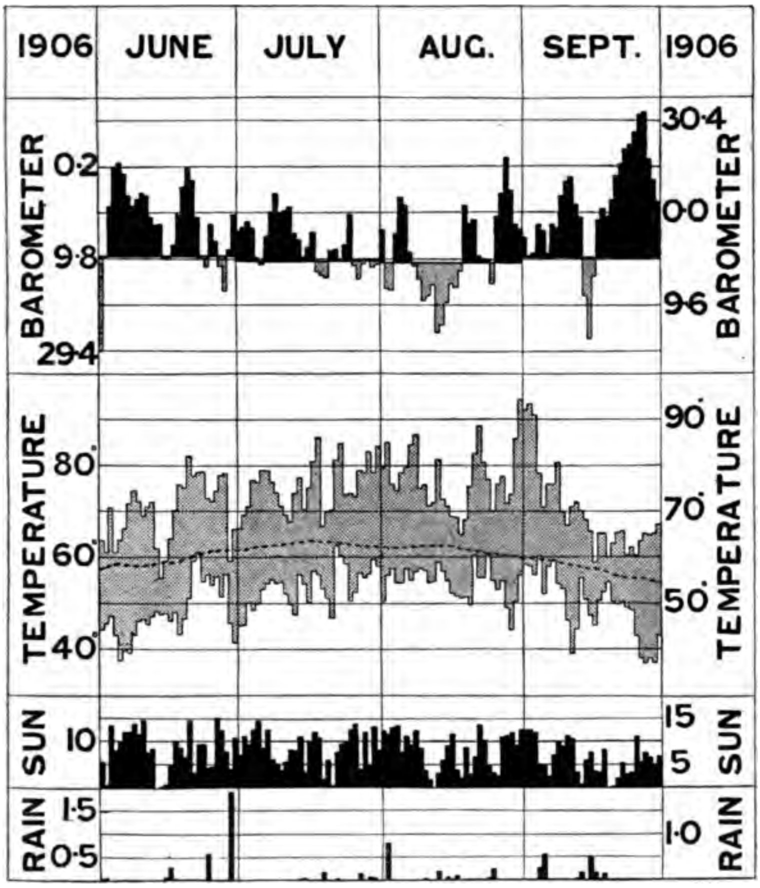

FIG. 1.

The general features, so far as the south-eastern parts of England are concerned, will be seen from Fig. 1, which gives in a diagrammatic form the daily readings of the barometer, the maximum and minimum temperatures, the amount of sunshine, and the rainfall at the Royal Observatory, Greenwich, during the four months June to September.

The chief feature which strikes one on looking at this diagram is the high state of the barometer throughout the whole of the period, except during a portion of August. The temperature was above the average in July, August, and September—the most remarkable point being the great heat at the end of August and the beginning of September. The sunshine was very abundant, the number of bright days being most marked. The rainfall throughout the whole of the period was very slight, with the exception of two or three heavy falls, notably that on June 28, when there was a fall of nearly two inches.

Barometer.

The barometer in June was very high, the mean being 30·121 ins. This high mean has only been exceeded in London on eight occasions between 1774 and the present year, viz.:—

1804 . .	30·157 ins.	1865 . .	30·205 ins.
1806 . .	30·148 ,,	1868 . .	30·153 ,,
1810 . .	30·135 ,,	1870 . .	30·121 ,,
1826 . .	30·234 ,,	1887 . .	30·197 ,,
1906 . .	30·121 ins.		

In September the barometer was exceptionally high, the mean for the month being 30·196 ins. This has only been exceeded on four occasions between 1774 and the present year, viz.:—

1843 . .	30·198 ins.	1854 . .	30·207 ins.
1851 . .	30·201 ,,	1865 . .	30·246 ,,
1906 . .	30·196 ins.		

By taking the whole period, June to September, we find that the barometer was above the average in each of the four months. There have only been, so far as I can ascertain, eight occasions between 1774 and the present time on which the means of the barometer for the four consecutive months have been above the average. These were in—

1778
1793
1803
1812
1870
1884
1904
1906

From the charts given in the *Monthly Weather Report* of the Meteorological Office, it appears that the mean barometric pressure over the British Isles for September was about a quarter of an inch above the average (Fig. 5).

In Figs. 2-5 the mean barometric pressure for each month is shown by the thick lines and the average by the dotted lines.

Temperature.

Table I. gives the mean temperature over the various districts of the British Isles for each week from June 2 to October 27, together with the difference from the average for the 35 years 1870-1905 (p. 8).

From this it will be seen that the temperature was above the average during the first four weeks, except in the eastern part of England. For the weeks ending June 30 to July 21 the weather was generally cool, but from July 28 to October 27 the temperature was considerably above the average, except during the week ending September 29, and also that of October 20. The greatest heat occurred during the weeks ending September 1 and 8, but this special feature will be dealt with a little later on.

Barometric Pressure.

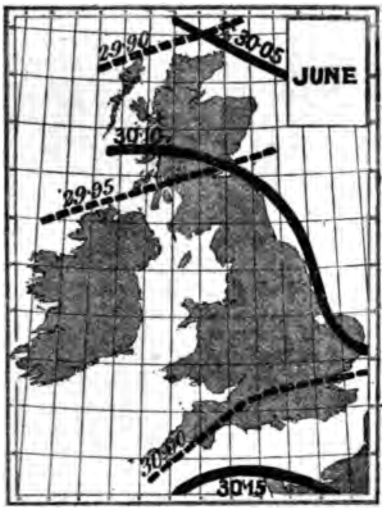

Fig. 2.

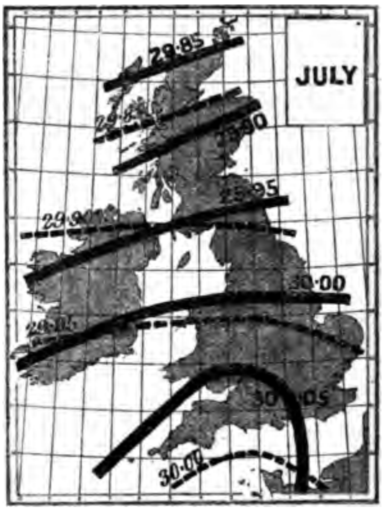

Fig. 3.

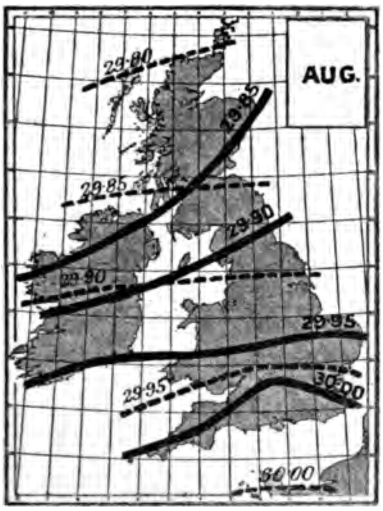

Fig. 4.

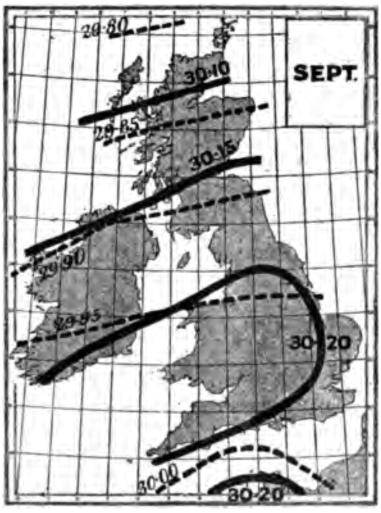

Fig. 5.

TABLE I.—MEAN TEMPERATURE, WITH DIFFERENCE FROM THE AVERAGE (35 YEARS), OF THE VARIOUS DISTRICTS OF THE BRITISH ISLES FOR EACH WEEK IN JUNE TO OCTOBER 1906.

Weeks ending	Scotland N.		Scotland E.		England NE.		England E.		Midland Counties.		England S.		Scotland W.		England NW.		England SW.		Ireland N.		Ireland S.		English Channel.	
	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.	Mean.	Diff. Av.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
June 2	48·9	-0·9	52·0	+1·1	55·9	+3·3	56·7	+2·3	55·5	+1·7	54·8	+0·3	53·1	+0·7	54·0	+0·7	53·5	-0·6	52·4	+0·1	54·3	+0·3	54·5	-0·5
„ 9	52·0	+1·1	54·6	+2·3	53·8	-0·2	52·6	-3·2	55·1	-0·1	54·5	-1·4	55·7	+2·0	55·7	+1·1	56·3	+0·9	54·9	+1·4	57·2	+2·1	56·7	+0·5
„ 16	53·9	+1·6	55·7	+2·0	54·3	-1·3	53·1	-4·2	55·4	-1·3	53·7	-3·6	57·8	+2·8	57·2	+1·2	56·9	+0·2	54·2	-0·5	58·9	+2·6	56·2	-1·2
„ 23	57·0	+3·7	58·4	+3·5	60·0	+3·1	61·2	+2·6	60·4	+2·5	60·8	+2·3	58·0	+2·0	59·1	+2·2	58·1	+0·4	58·5	+2·9	60·2	+2·8	60·1	+1·7
„ 30	51·4	-2·6	53·8	-2·0	58·1	+0·2	59·7	0·0	57·9	-0·9	58·4	-1·1	53·8	-2·9	56·3	-1·4	57·3	-1·2	54·2	-2·2	56·4	-1·7	59·6	+0·3
July 7	52·7	-1·9	54·4	-2·1	58·1	-0·5	58·6	-1·9	59·2	-0·3	59·4	-1·0	55·3	-1·8	57·5	-0·9	58·3	-0·9	55·4	-1·5	57·5	-1·1	60·5	+0·4
„ 14	53·0	-1·9	55·4	-1·5	58·3	-0·9	60·1	-1·2	57·4	-2·6	59·2	-1·8	55·0	-2·5	55·6	-3·3	56·8	-3·0	54·9	-2·3	57·5	-1·4	59·1	-1·7
„ 21	51·3	-3·6	55·1	-1·8	59·7	+0·4	61·2	-0·3	60·0	-0·1	60·0	-1·4	55·0	-2·5	57·8	-1·3	58·9	-1·2	55·7	-1·5	59·6	+0·6	60·1	-1·2
„ 28	55·3	+0·4	57·1	+0·4	61·5	+2·4	64·3	+2·9	62·4	+2·5	63·3	+1·9	57·4	-0·1	60·8	+1·7	61·0	+1·0	57·9	+0·8	60·3	+1·4	63·3	+1·9
Aug. 4	57·3	+2·3	59·0	+2·4	63·4	+4·4	66·2	+4·9	63·6	+3·8	64·7	+3·4	59·8	+2·4	61·7	+2·7	60·9	+1·0	58·5	+1·3	60·0	+1·0	63·2	+1·6
„ 11	55·6	+0·5	56·5	-0·1	60·2	+1·1	64·2	+2·9	63·1	+3·4	63·8	+2·5	59·1	+1·9	61·3	+2·4	62·7	+2·7	59·1	+1·8	60·8	+1·5	63·5	+1·6
„ 18	55·0	+0·1	55·5	-0·7	59·6	+0·9	61·9	+0·9	59·4	+0·2	60·7	-0·4	57·2	+0·2	58·4	-0·2	59·4	-0·5	56·6	-0·6	58·2	-0·7	61·6	-0·2
„ 25	53·7	-0·6	55·8	+0·4	61·2	+3·3	63·9	+3·6	63·1	+4·6	63·0	+2·7	57·4	+1·1	60·0	+2·1	61·9	+2·9	59·0	+2·4	61·1	+2·8	63·0	+1·7
Sept. 1	58·2	+4·8	60·7	+6·2	63·8	+6·8	63·4	+4·2	64·7	+7·2	64·8	+5·3	61·5	+6·1	63·6	+6·4	63·7	+5·6	62·8	+7·0	62·8	+5·4	65·4	+4·7
„ 8	56·6	+3·7	59·2	+5·6	63·8	+7·9	66·9	+8·6	65·1	+8·6	65·4	+6·8	59·1	+4·5	61·4	+5·1	63·1	+5·7	58·5	+3·5	61·4	+4·7	63·6	+3·5
„ 15	52·3	+0·2	53·3	+0·6	56·0	+0·7	57·9	+0·8	55·7	+0·1	58·2	+0·5	53·9	+0·1	55·5	0·0	56·5	-0·2	53·9	-0·3	54·9	-0·9	61·6	+2·0
„ 22	53·0	+1·8	52·1	+0·3	54·4	+0·2	56·4	+0·4	54·7	+0·2	56·3	-0·4	54·3	+1·5	54·2	-0·3	54·5	-1·2	55·1	+1·8	55·9	+1·0	58·9	+0·2
„ 29	50·9	+0·9	50·3	-0·3	51·6	-1·2	52·4	-2·2	50·4	-2·6	52·9	-2·3	51·0	-0·5	50·8	-2·3	52·8	-1·7	52·4	+0·2	53·6	-0·1	58·2	+0·5
Oct. 6	51·0	+2·2	51·7	+2·4	55·2	+3·9	58·1	+5·1	55·8	+4·2	57·8	+4·2	52·6	+2·2	55·4	+3·6	56·9	+3·7	53·3	+2·4	56·1	+3·6	50·4	+3·9
„ 13	50·5	+3·3	51·8	+4·3	55·5	+6·0	58·5	+7·4	54·9	+5·3	57·9	+6·3	52·8	+4·0	54·3	+4·1	54·6	+3·2	51·7	+2·4	53·0	+2·1	57·8	+2·8
„ 20	42·3	-3·2	42·9	-2·6	46·8	-0·7	50·9	+2·0	48·0	+0·4	51·3	+1·8	46·0	-1·0	46·8	-1·6	49·6	+0·1	45·4	-2·3	47·1	-2·1	54·1	+0·7
„ 27	47·9	+3·5	47·3	+3·3	50·6	+4·8	52·7	+5·5	55·8	+4·8	53·3	+5·5	49·7	+4·0	51·3	+4·4	52·2	+4·1	49·2	+2·6	51·2	+3·2	56·2	+4·2

TABLE II.—RAINFALL, WITH DIFFERENCE FROM THE AVERAGE (35 YEARS), OVER THE VARIOUS DISTRICTS OF THE BRITISH ISLES FOR EACH WEEK IN JUNE TO OCTOBER 1906.

Weeks ending	Scotland N.		Scotland E.		England NE.		England E.		Midland Counties.		England S.		Scotland W.		England NW.		England SW.		Ireland N.		Ireland S.		English Channel.	
	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
June 2	0·84	+0·23	0·68	+0·19	0·29	-0·14	0·34	-0·09	0·37	-0·12	0·30	-0·12	0·96	+0·30	0·59	+0·09	0·48	-0·04	0·88	+0·32	0·50	-0·09	0·14	-0·29
,, 9	0·02	-0·58	0·05	-0·45	0·00	-0·44	0·00	-0·45	0·00	-0·51	0·00	-0·45	0·00	-0·68	0·00	-0·54	0·00	-0·54	0·00	-0·58	0·02	-0·59	0·00	-0·44
,, 16	0·03	-0·58	0·23	-0·29	0·55	+0·10	0·36	-0·12	0·54	0·00	0·36	-0·12	0·15	-0·55	0·17	-0·37	0·37	-0·20	0·08	-0·52	0·12	-0·52	0·09	-0·38
,, 23	0·23	-0·40	0·38	-0·16	0·50	+0·04	0·32	-0·17	0·53	-0·02	0·30	-0·19	0·66	-0·07	0·57	0·00	0·61	+0·02	0·94	+0·32	1·06	+0·42	0·04	-0·45
,, 30	0·91	+0·24	0·26	-0·31	0·27	-0·23	1·69	+1·18	1·02	+0·46	1·18	+0·69	0·52	-0·24	0·66	+0·05	1·25	+0·63	0·51	-0·14	0·80	+0·14	0·95	+0·45
July 7	0·08	-0·64	0·21	-0·40	0·17	-0·37	0·00	-0·53	0·05	-0·52	0·02	-0·48	0·52	-0·28	0·17	-0·49	0·16	-0·50	0·37	-0·30	0·59	-0·08	0·04	-0·47
,, 14	0·60	-0·17	0·33	-0·32	0·13	-0·43	0·10	-0·45	0·29	-0·30	0·18	-0·33	0·58	-0·25	0·58	-0·12	0·30	-0·39	0·49	-0·20	0·41	-0·29	0·17	-0·36
,, 21	3·23	+2·41	0·49	-0·19	0·05	-0·53	0·15	-0·41	0·11	-0·49	0·23	-0·29	1·40	+0·55	0·48	-0·25	0·41	-0·30	0·59	-0·13	0·34	-0·37	0·38	-0·15
,, 28	0·52	-0·34	0·26	-0·43	0·33	-0·26	0·16	-0·39	0·41	-0·20	0·18	-0·36	0·49	-0·40	0·26	-0·50	0·34	-0·39	0·56	-0·20	0·85	+0·10	0·08	-0·46
Aug. 4	1·62	+0·74	1·60	+0·89	0·72	+0·13	0·33	-0·22	0·35	-0·26	0·18	-0·37	1·49	+0·55	1·27	+0·49	1·19	+0·43	1·01	+0·21	1·49	+0·67	0·33	-0·22
,, 11	0·54	-0·38	0·85	+0·11	0·87	+0·27	0·43	-0·11	0·22	-0·40	0·07	-0·49	0·69	-0·31	0·41	-0·40	0·23	-0·56	0·86	-0·02	0·38	-0·52	0·12	-0·45
,, 18	0·75	-0·21	1·08	+0·33	0·74	+0·14	0·41	-0·12	0·62	-0·01	0·53	-0·03	1·36	+0·33	1·51	+0·69	1·04	+0·23	0·96	+0·07	0·83	-0·10	0·65	+0·07
,, 25	1·12	+0·13	1·40	+0·67	0·69	+0·10	0·23	-0·30	0·38	-0·24	0·21	-0·36	1·66	+0·61	1·06	+0·24	0·65	-0·16	1·24	+0·36	0·74	-0·17	0·20	-0·41
Sept. 1	0·17	-0·85	0·09	-0·61	0·02	-0·54	0·00	-0·53	0·00	-0·61	0·00	-0·57	0·08	-0·96	0·03	-0·78	0·00	-0·80	0·02	-0·84	0·01	-0·84	0·00	-0·64
,, 8	1·57	+0·54	0·45	-0·23	0·00	-0·54	0·20	-0·32	0·04	-0·55	0·46	-0·11	0·75	-0·28	0·30	-0·49	0·07	-0·73	0·35	-0·47	0·28	-0·52	0·31	-0·35
,, 15	1·46	+0·34	0·57	-0·08	0·44	-0·07	0·52	+0·01	0·75	+0·19	0·61	+0·04	1·27	+0·24	0·92	+0·15	1·11	+0·31	0·99	+0·20	0·70	-0·07	0·69	-0·01
,, 22	0·02	-1·09	0·04	-0·60	0·21	-0·29	0·70	+0·18	0·15	-0·41	0·24	-0·35	0·06	-0·98	0·07	-0·70	0·00	-0·81	0·02	-0·76	0·01	-0·75	0·04	-0·71
,, 29	0·00	-1·12	0·00	-0·65	0·00	-0·53	0·00	-0·52	0·00	-0·58	0·00	-0·62	0·00	-1·07	0·00	-0·80	0·00	-0·86	0·07	-0·72	0·00	-0·78	0·00	-0·80
Oct. 6	0·28	-0·90	0·46	-0·23	0·87	+0·28	0·92	+0·35	1·51	+0·90	1·05	+0·36	1·00	-0·09	1·28	+0·42	2·45	+1·54	0·74	-0·07	1·43	+0·59	0·71	-0·15
,, 13	0·99	-0·23	1·30	+0·59	0·63	0·00	0·63	+0·04	0·99	+0·35	1·14	+0·40	1·23	+0·11	0·85	-0·03	1·09	+0·12	1·06	+0·24	1·38	+0·51	1·27	+0·35
,, 20	1·71	+0·46	2·42	+1·69	1·82	+1·17	0·41	-0·20	1·20	+0·55	0·72	-0·05	1·00	-0·14	1·79	+0·89	1·06	+0·06	0·64	-0·19	0·74	-0·15	0·88	-0·10
,, 27	1·94	+0·70	1·08	+0·35	0·42	-0·24	0·38	-0·22	0·32	-0·32	0·22	-0·55	2·01	+0·87	1·06	+0·17	0·51	-0·49	1·59	+0·75	1·53	+0·63	0·14	-0·84

Rainfall.

Table II. gives the rainfall over the various districts of the British Isles for each week from June 2 to October 27, together with the difference from the average for the 35 years 1870-1905 (p. 9).

RAINFALL OF JUNE, 1906.

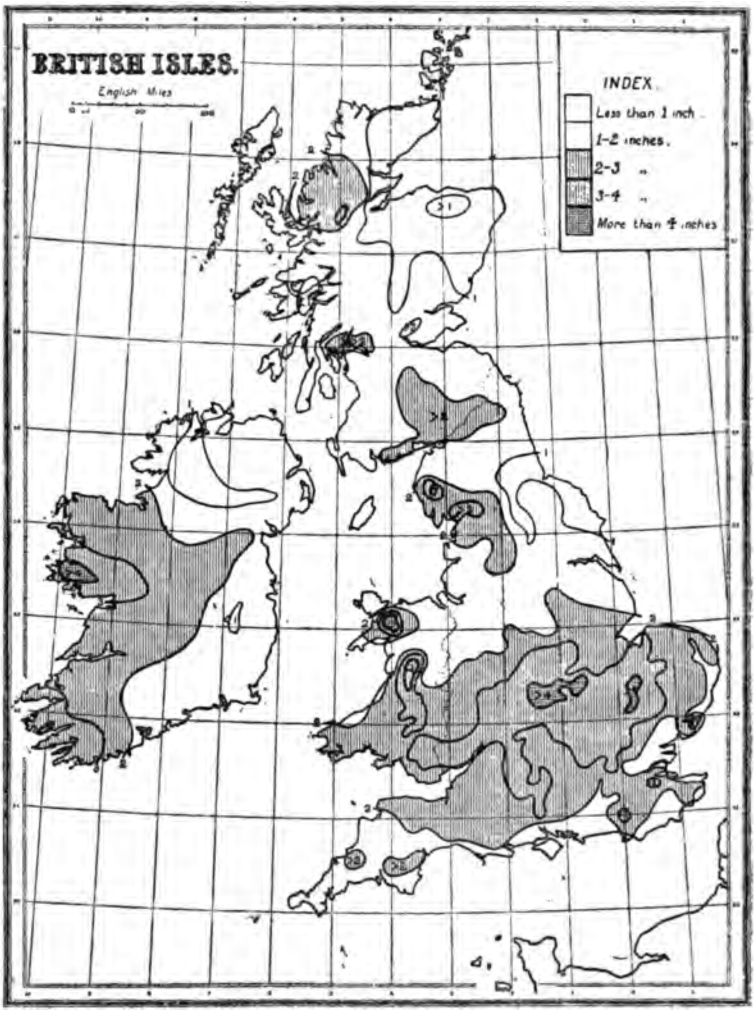

FIG. 6.

Dr. H. R. Mill has kindly placed his monthly charts of rainfall for the British Isles for the months of June to September at my disposal, and these are reproduced in Figs. 6-9.

The following extracts from an article by Dr. Mill in *Symons's*

Meteorological Magazine for October will perhaps give the best idea as to the distribution of rainfall during the summer.

RAINFALL OF JULY, 1906.

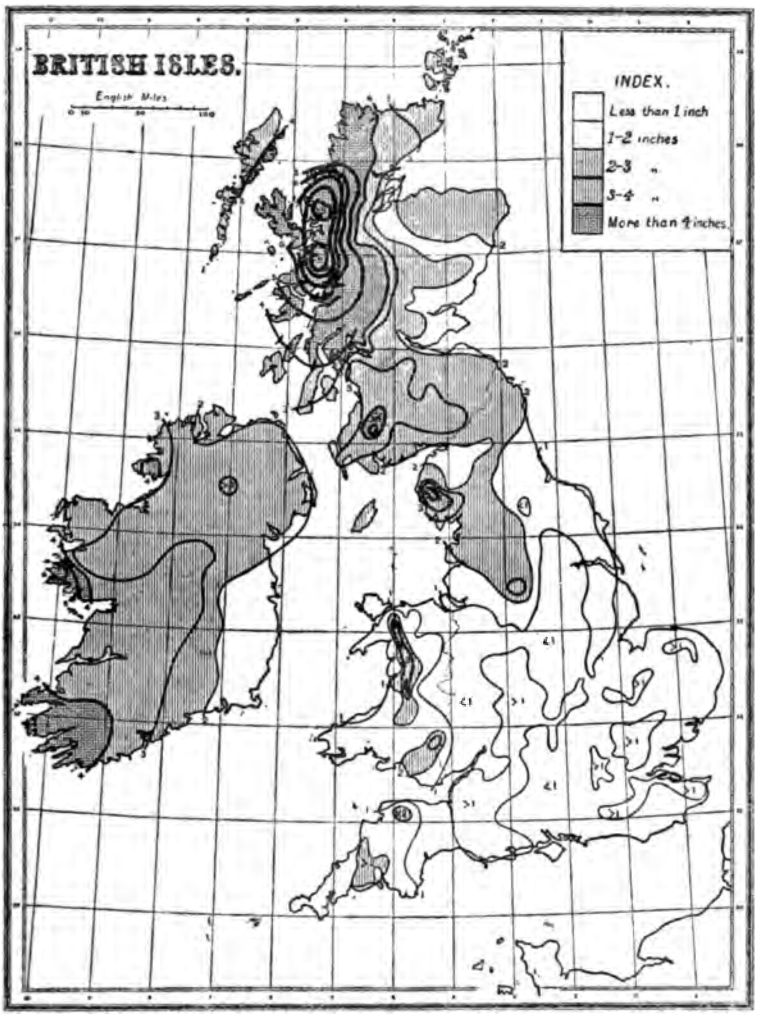

FIG. 7.

"The following figures show the rainfall over the various portions of the British Isles in percentages of the average, viz. :—

	June.	July.	Aug.	Sept.
England and Wales	101	36	74	39
Scotland	49	83	117	52
Ireland	66	81	89	40
British Isles	81	57	88	42

"England and Wales had technically more than the average in June, and Scotland in August. The driest month was September, when the rainfall for the British Isles as a whole was less than half the average amount, and in England did not much exceed one-third of the average. The rainfall in September did not approach the average at any station, and only in the extreme west and north of Scotland, and in the extreme south-east of England, did it substantially exceed half the average. The driest area was in the south-east of Scotland, and in the north-east of England, in a strip of country bordering the east coast, from the Forth to the Humber. It was very dry also along the estuary of the Severn.

RAINFALL OF AUGUST, 1906.

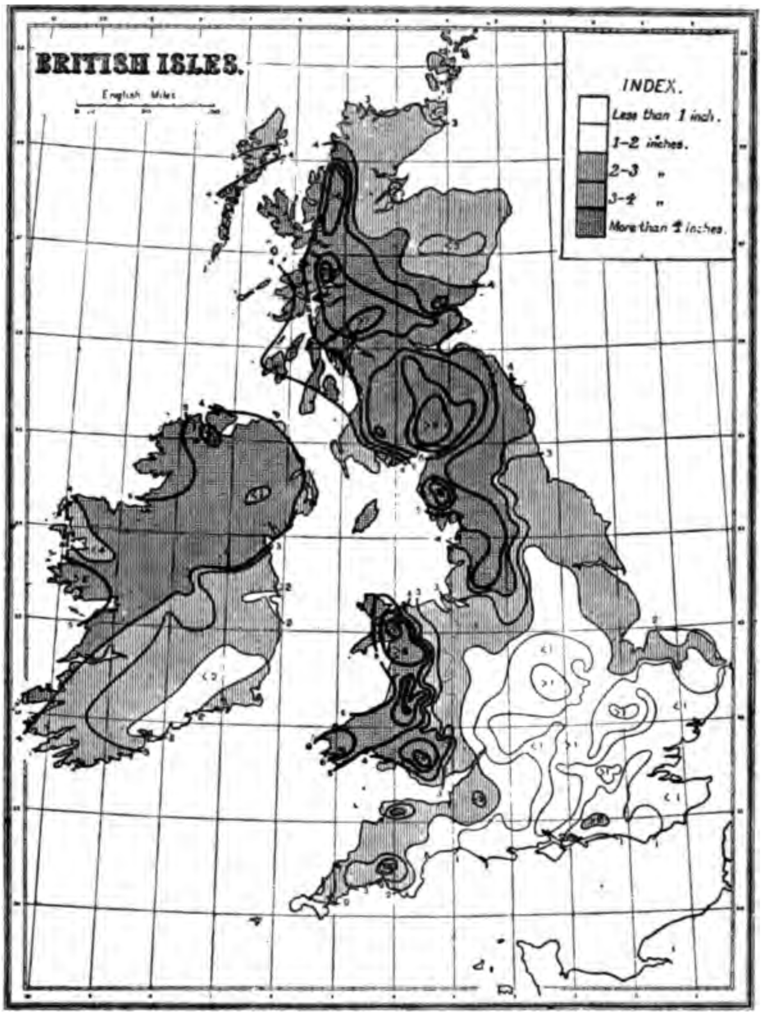

FIG. 8.

"During September absolute droughts occurred at several stations, where no rain fell till after the 16th; but neither absolute droughts nor partial droughts, in the technical sense, were so common as in many periods of six months with a greater total rainfall.

"In June, Scotland as a whole was dry, Ireland less dry, and England and Wales wet; but in the other months the deficiency of rainfall was greatest in the south and east, while there was usually an excess in the north and west.

RAINFALL OF SEPTEMBER, 1906.

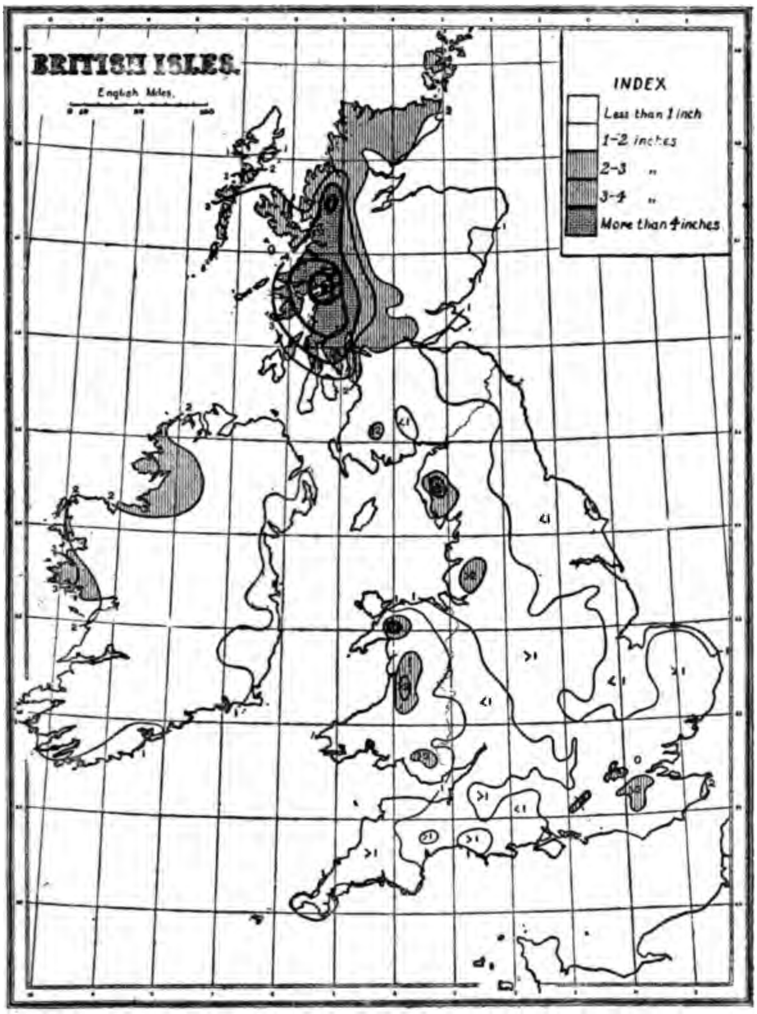

FIG. 9.

"On taking the average for the six months (April to September), there was a distinct excess of rainfall in the extreme north of Scotland, and also in the south-west of Scotland, and in the extreme north of England. All the remainder of the British Isles was dry, but the west and north of Ireland, and the greater part of Wales and the north of England, had not much less than the average fall. A marked deficiency was apparent only in the south-east of Ireland, and in the Midlands and south of England.

"The area seriously affected by the reduced rainfall was practically confined to the centre and south of England.

"The extremes of rainfall during the six months were at Cargen, near Dumfries, where there was an excess of 3·70 ins., the total fall being 120 per cent of the average; and Torquay, where there was a deficiency of 7·25 ins., the total fall being only 52 per cent of the average, or scarcely more than one half. At Derby the deficiency was 7·03 ins., and as it has normally a somewhat lower rainfall than Torquay, the actual fall was only 49 per cent of the average. Both these extreme cases were, fortunately for the country, not typical of any large area."

In the *Berks and Oxon Advertiser* for September 28 it was stated: "The drought is felt so acutely on the Chiltern Hills that drinking water is being sold at Stokenchurch at 2d. a bucket.

River Thames and Rainfall.

Mr. J. C. More, M.Inst.C.E., the engineer of the Thames Conservancy, has favoured me with particulars of the daily quantities of water abstracted from the river Thames for Water Supply by the Metropolitan Water Board and Water Companies, the gaugings at Teddington Weir, and the rainfall in the Thames Basin for each day from January 1 to September 30. In Table III. are given the daily means for each month, and also the total rainfall, together with the difference from the average values for the preceding 23 years. It will thus be seen that the quantity flowing over Teddington Weir has been below the average in each month except January. The small difference from the average in July is no doubt due to the exceptionally heavy rainfall which occurred over the whole of the Thames Basin on June 28.

TABLE III.—FLOW OF RIVER THAMES AND THE RAINFALL IN THE THAMES BASIN.

1906.	Abstracted for Water Supply.		Gauged at Teddington Weir.		Natural Flow at Teddington Weir.		Average Rainfall at 12 Stations.	
	Millions of Gallons.	Difference from Average	Millions of Gallons.	Difference from Average.	Millions of Gallons.	Difference from Average.	Inches.	Difference from Average.
January . .	101·8	+ 5·3	3123·8	+1124·3	3225·6	+1129·6	4·55	+2·39
February . .	135·8	+40·6	1975·3	− 292·5	2111·1	− 251·9	2·21	+ ·23
March . .	134·1	+39·2	1485·1	− 245·8	1619·2	− 206·6	1·58	− ·36
April . .	126·0	+27·9	788·5	− 332·8	914·5	− 304·9	·68	− ·93
May . .	135·1	+30·1	552·3	− 296·0	687·4	− 265·9	1·73	− ·20
June . .	150·0	+37·0	295·4	− 376·9	445·4	− 339·9	2·70	+ ·56
July . . .	150·8	+30·5	235·6	− 189·8	386·4	− 159·3	·82	−1·51
August . .	129·6	+15·7	137·2	− 235·9	266·8	− 220·2	1·14	−1·38
September .	140·6	+29·4	107·6	− 270·1	248·2	− 240·7	1·13	− ·87

Percolation.

Mr. E. Mawley has sent me the following particulars regarding the percolation through his two gauges, which are each one yard square and contain 2½ feet of the ordinary soil of the district:—

1906.	Bare soil or uncropped gauge.		Gauge on which short grass is growing.	
April . . .	·045 in.	All on 13th. A few drops only each day before and after that date.	...	A few drops on first seven days.
May	...	A few drops only each day during the month.	...	...
June . . .	1·353 in.	All on 2nd, 28th, 29th, and 30th. A few drops only on other days.	·977 in.	All on 28th and 29th.
July . . .	·078 in.	All on first seven days. Afterwards a few drops each day till the 30th, then none at all.	...	...
August . .	...	......	...	...
September .	·278 in.	All on the six days ending the 21st. Before then none, afterwards a few drops each day.	...	...
Total for six months . .	1·754 in.		·977 in.	

Sunshine.

Table IV. gives the hours of sunshine over the various districts of the British Isles for each week from June 2 to October 27, together with the difference from the average of the 25 years 1880-1905 (p. 16). The sunshine during the whole of this period was most brilliant, and was considerably above the average.

The sunshine was such a prominent feature of the weather of the past summer, that it seems desirable to put upon record some of the salient features. These are shown in Table V., which gives the total number of hours of sunshine for the whole period, together with the difference from the average; also the number of days on which there were more than ten hours, and also eight hours and above of sunshine, in each of the four months, June, July, August, and September; and the total number of sunless days during the whole period.

The results are shown in a diagrammatic form in Fig. 10. From this it will be seen that over the south-eastern portion of England more than 900 hours of sunshine were recorded during the period. At a few stations in the extreme south and on the east coast more than 1000 hours were recorded. More than 800 hours were recorded along the whole of the western coasts of England and Wales, and over the southern part of England, practically south of a line from the Bristol Channel to the Humber. More than 700 hours was recorded over the other parts of England and Wales and south-east of Scotland, except in the manufacturing districts, where, owing to the great amount of smoke in the atmosphere, the sun's rays were considerably weakened. Over practically the whole of Ireland and the greater part of Scotland, 600 hours were registered; while on the extreme western coasts of Scotland and the north of Ireland, less than 600 hours were recorded.

Over the Thames basin and the coasts of Lancashire and North Wales there were more than 200 hours of sunshine above the average; while over practically the whole of England and Wales and the southern part of Scotland the sunshine was more than 100 hours in excess of the

TABLE IV.—Hours of Sunshine, with Difference from the Average (25 Years), over the Various Districts of the British Isles for each Week in June to October 1906.

Week ending	Scotland N.		Scotland E.		England NE.		England E.		Midland Counties		England S.		Scotland W.		England NW.		England SW.		Ireland N.		Ireland S.		English Channel.	
	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.	Total.	Diff. Av.
June 2 . .	17	- 21	33	- 6	40	+ 4	39	- 9	36	- 7	37	- 9	34	- 11	31	- 14	31	- 19	18	- 23	24	- 26	29	- 27
,, 9 . .	33	- 4	50	+ 9	59	+ 18	72	+ 28	69	+ 32	80	+ 34	61	+ 16	73	+ 27	77	+ 33	58	+ 17	63	+ 18	88	+ 31
,, 16 . .	44	+ 7	51	+ 8	37	- 3	34	- 7	38	0	35	- 11	57	+ 13	51	+ 4	54	+ 8	49	+ 9	58	+ 17	51	- 6
,, 23 . .	40	+ 4	34	- 8	49	+ 6	68	+ 18	52	+ 14	75	+ 27	29	- 15	41	- 1	34	- 13	23	- 16	20	- 24	50	- 7
,, 30 . .	30	- 5	38	- 1	35	- 6	51	+ 3	36	- 11	49	+ 2	46	+ 3	40	- 3	33	- 15	38	+ 1	39	0	48	- 9
July 7 . .	44	+ 10	44	+ 5	55	+ 7	76	+ 28	53	+ 17	67	+ 21	51	+ 9	50	+ 5	53	+ 10	26	- 9	28	- 11	68	+ 12
,, 14 . .	36	+ 5	47	+ 9	48	+ 8	44	- 3	43	+ 2	52	+ 5	53	+ 13	54	+ 12	56	+ 11	34	+ 2	34	- 7	60	+ 5
,, 21 . .	26	- 3	46	+ 11	54	+ 15	48	+ 2	45	+ 2	40	- 9	44	+ 6	38	+ 1	29	- 20	33	+ 2	30	- 4	26	- 29
,, 28 . .	38	+ 10	38	+ 4	55	+ 13	65	+ 21	59	+ 19	75	+ 28	41	+ 4	47	+ 8	53	+ 9	50	+ 19	49	+ 15	67	+ 13
Aug. 4 . .	33	+ 5	32	- 2	50	+ 4	66	+ 19	49	+ 10	71	+ 22	32	- 4	42	+ 4	47	+ 2	33	+ 3	42	+ 6	63	+ 9
,, 11 . .	19	- 8	26	- 9	38	- 5	55	+ 10	47	+ 10	54	+ 7	31	- 5	43	+ 6	39	- 8	30	0	32	- 2	47	- 8
,, 18 . .	30	+ 3	26	- 8	33	- 5	39	- 4	33	- 4	38	- 7	26	- 9	25	- 9	44	+ 4	37	+ 8	41	+ 3	54	0
,, 25 . .	26	+ 1	27	- 7	39	+ 3	44	+ 4	46	+ 12	48	+ 5	32	- 2	40	+ 7	42	- 2	21	- 8	29	- 4	51	- 2
Sept. 1 . .	30	+ 5	46	+ 18	60	+ 26	70	+ 31	68	+ 34	67	+ 26	49	+ 16	67	+ 36	65	+ 26	55	+ 27	55	+ 25	66	+ 17
,, 8 . .	32	+ 7	43	+ 16	50	+ 15	55	+ 17	48	+ 17	50	+ 12	40	+ 9	40	+ 9	41	+ 3	26	- 1	36	+ 2	44	- 1
,, 15 . .	35	+ 11	35	+ 11	49	+ 18	50	+ 16	46	+ 16	45	+ 9	45	+ 16	46	+ 15	46	+ 11	43	+ 17	49	+ 18	52	+ 9
,, 22 . .	34	+ 10	35	+ 7	23	- 12	31	- 3	20	- 7	31	- 3	36	+ 8	39	+ 11	49	+ 15	31	+ 6	32	+ 1	51	+ 12
,, 29 . .	43	+ 20	55	+ 27	47	+ 14	49	+ 16	41	+ 18	48	+ 16	43	+ 18	51	+ 23	58	+ 28	44	+ 19	46	+ 17	64	+ 28
Oct. 6 . .	16	- 5	18	- 5	17	- 11	27	- 3	13	- 11	29	- 1	11	- 12	13	- 10	14	- 14	12	- 10	16	- 12	25	- 7
,, 13 . .	18	- 2	15	- 7	25	- 2	37	+ 8	16	- 7	31	+ 4	16	- 5	16	- 5	26	+ 3	25	+ 4	31	+ 5	26	- 3
,, 20 . .	23	+ 5	22	+ 4	27	+ 4	26	+ 4	25	+ 2	29	+ 5	23	+ 4	20	+ 3	20	- 5	29	+ 9	24	+ 1	25	- 2
,, 27 . .	15	- 1	22	+ 5	23	+ 2	26	+ 6	22	+ 4	30	+ 8	20	+ 3	23	+ 4	26	+ 6	19	0	23	+ 4	35	+ 11

average. The only station reporting less sunshine than the average was Stornoway in the Hebrides.

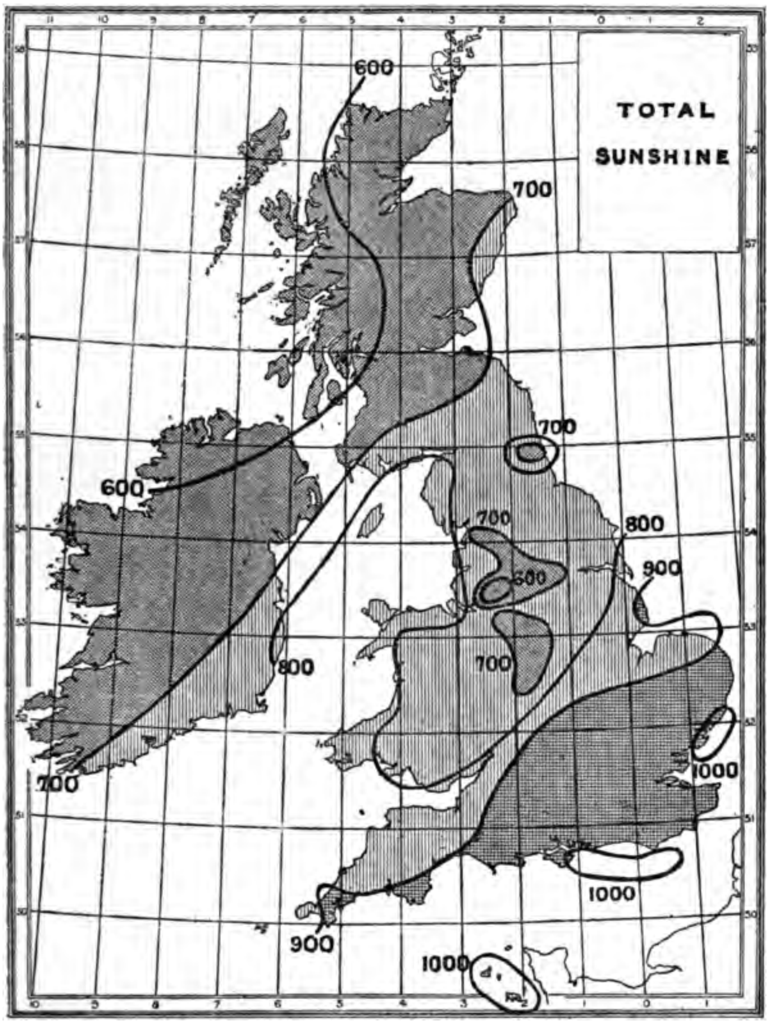

FIG. 10.—Total Hours of Sunshine, June to September.

Wind.

The wind during the summer was generally light in force, and consequently there were more calms than usual. This largely assisted the formation of fog round the coasts, which was very dense on several occasions. The fog not only affected the steamboat traffic, but also was the cause of numerous accidents, the most serious of which was the stranding of H.M.S. *Montagu* off Lundy Island.

TABLE V.—NUMBER OF DAYS OF SUNSHINE ABOVE 10 HOURS AND 8 HOURS, NUMBER OF SUNLESS DAYS, AND THE NUMBER OF HOURS OF SUNSHINE WITH THE DIFFERENCE FROM THE AVERAGE, JUNE TO SEPTEMBER 1906.

STATIONS.	Days of Sunshine.										June-September.		
	June.		July.		August.		September.		Total.		Sunless Days.	Hours of Sunshine.	
	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.		Total.	Diff. from Average.
SCOTLAND, N.													
Deerness, Orkney	3	4	6	8	7	7	4	9	20	28	14	610·4	+ 90·1
Strathpeffer . .	7	10	5	9	1	4	3	9	16	32	7	660·0	+131·3
Stornoway . .	6	7	5	9	1	2	2	7	14	25	8	565·4	− 12·1
Fort Augustus .	5	10	1	7	0	4	0	5	6	26	7	516·8	+108·8
SCOTLAND, E.													
Aberdeen . . .	8	11	6	11	6	9	6	13	26	44	8	712·3	+ 86·4
Edinburgh . .	8	9	6	10	2	4	3	4	19	27	11	627·3	+ 83·4
Marchmont . .	8	11	10	13	8	9	3	13	29	46	6	743·1	+121·5
ENGLAND, N.E.													
Newcastle . .	2	5	6	9	1	6	0	5	9	25	7	569·0	+ 48·5
Durham . . .	9	13	10	13	5	5	6	10	30	41	5	724·6	+117·5
York	7	11	6	13	5	10	4	10	22	44	5	736·3	+111·1
ENGLAND, E.													
Hillington . .	11	13	10	16	9	13	6	13	36	55	5	876·6	+160·4
Geldeston . .	12	14	12	15	10	14	5	12	39	55	1	922·2	+153·1
Cambridge . .	12	18	11	13	8	16	4	11	35	58	2	903·3	+157·7
Rothamsted . .	13	17	11	19	12	19	8	14	44	69	0	971·4	+226·0
MIDLAND CO.													
Hodsock . . .	8	11	7	13	7	10	3	8	25	42	6	701·7	+104·3
Strelley . . .	8	12	9	14	8	10	4	12	29	48	6	761·8	+165·6
Berkhamsted .	12	16	9	13	11	16	6	13	38	58	1	905·5	+197·8
Oxford . . .	11	15	11	17	13	17	7	11	42	60	2	917·4	+191·5
Cirencester . .	12	17	12	17	11	16	9	15	44	65	2	938·7	+223·2
ENGLAND, S.													
Bunhill Row, E.C.	7	15	13	17	9	18	4	7	33	57	3	831·9	+184·0
Greenwich . .	11	15	12	17	13	18	7	9	43	59	2	938·2	+286·8
Kew	14	16	11	15	12	18	...	...	...	...	...	901·0	+168·1
Southampton .	13	19	12	18	8	14	7	13	40	64	0	963·2	+160·1
Tunbridge Wells	13	17	15	19	12	15	7	10	47	61	1	994·6	+230·7
Margate . . .	10	14	14	16	13	17	8	11	45	58	3	936·9	+203·9
Hastings . . .	13	15	12	21	12	16	9	13	46	65	3	982·2	+132·5
Eastbourne . .	15	19	14	21	14	18	8	13	51	71	1	1021·7	+184·6
Brighton . . .	13	16	12	15	13	16	6	10	44	57	6	902·4	+ 62·2
Ventnor . . .	14	17	12	17	14	17	6	14	46	65	0	960·6	+166·1
SCOTLAND, W.													
Glasgow . . .	6	10	8	12	2	4	1	4	17	30	8	612·0	+ 71·3
Cronkbourne, I.M.	10	15	11	15	5	7	5	15	31	52	4	859·2	+121·3

TABLE V.—NUMBER OF DAYS OF SUNSHINE, ETC.—*continued.*

STATIONS.	Days of Sunshine.										June-September.		
	June.		July.		August.		September.		Total.		Sunless Days.	Hours of Sunshine.	
	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.	Above 10 hrs.	Above 8 hrs.		Total.	Diff. from Average.
ENGLAND, N.W.													
Newton Rigg	9	13	9	13	6	7	7	11	31	44	2	798·9	+136·6
Stonyhurst	8	12	8	13	6	13	3	9	25	47	7	751·5	+ 98·1
Bolton	1	5	4	8	0	5	1	2	6	20	6	533·4	+ 18·0
Prestwich	6	11	5	12	4	11	2	6	17	40	4	714·5	+134·0
Blackpool	13	16	12	18	8	15	5	14	38	63	4	882·0	+203·7
Llandudno	12	13	9	16	9	12	9	17	39	58	1	886·8	+201·0
ENGLAND, S.W.													
Pembroke (St. Ann's Head)	11	13	12	16	7	13	8	14	38	56	9	842·2	+ 68·0
Tenby	12	15	10	14	9	13	9	16	40	58	9	848·8	+ 62·9
Cullompton	12	17	7	13	6	10	8	13	33	53	5	852·9	+142·4
Torquay	12	18	10	21	8	17	10	13	40	69	0	985·9	+161·6
Plymouth	13	16	9	17	9	13	10	14	41	60	7	893·9	+118·0
Newquay	11	16	12	14	10	15	9	17	42	62	7	903·4	+108·1
Falmouth	11	18	11	16	10	14	10	17	42	65	5	918·6	+ 90·4
IRELAND, N.													
Armagh	5	8	6	9	5	8	6	11	22	36	5	681·6	+118·0
Markree	5	12	2	6	3	3	3	8	13	29	10	604·9	+ 68·6
IRELAND, S.													
Dublin (Phœnix Park)	7	13	3	9	3	10	4	10	17	42	3	753·5	+ 81·6
Parsonstown	2	8	3	7	4	7	4	10	13	32	12	656·3	+ 77·7
Valencia	9	14	4	10	4	8	3	9	20	41	9	672·4	+ 49·3
CHANNEL IS.													
Scilly	14	17	10	14	11	15	8	18	43	64	8	883·5	+ 22·7
Jersey	15	17	18	20	14	17	11	15	58	69	2	1017·8	+101·2
Guernsey (Villa Carey)	12	15	15	19	14	17	8	18	49	69	1	1020·5	+ 97·5
Guernsey (Fort Road)	12	16	16	20	15	18	9	16	52	70	1	1030·7	+ 87·5

Thunderstorms.

Several thunderstorms occurred between July 27 and August 17. That on the evening of August 2 was of a most remarkable character, the lightning being incessant, while the storm was apparently at a considerable altitude above the earth. Great destruction was caused in the neighbourhood of Guildford by a violent tornado which passed over that place. Also a severe hailstorm occurred on the borders of the counties of Cambridge, Huntingdon, and Bedfordshire on the same evening. I do not propose to refer further to these storms, as Admiral Maclear will communicate a paper on the subject at the next meeting of the Society (see pp. 41 and 60).

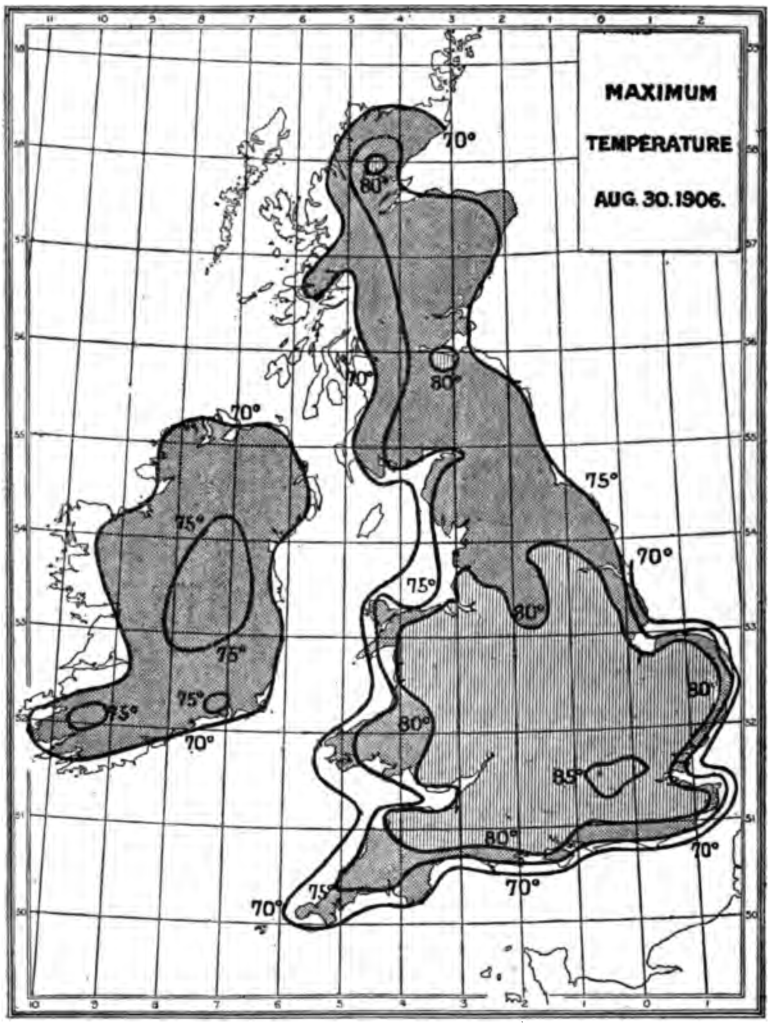

Fig. 11.

The Great Heat of August 30 *to September* 3.

The most remarkable feature of the weather during the past summer was the exceptional heat wave which occurred between August 30 and September 3. The temperatures recorded during this period were so abnormally high that I have considered it desirable to prepare daily maps showing by isotherms the distribution of the maximum temperatures over the country (Figs. 11-15). These maps are based upon the returns from more than 250 stations.

From these it appears that over nearly the whole of England and Wales the temperature reached 80° on August 30; while in and round London the temperature rose to over 85°; and practically over the whole of the British Isles the temperature rose to more than 70° on that day.

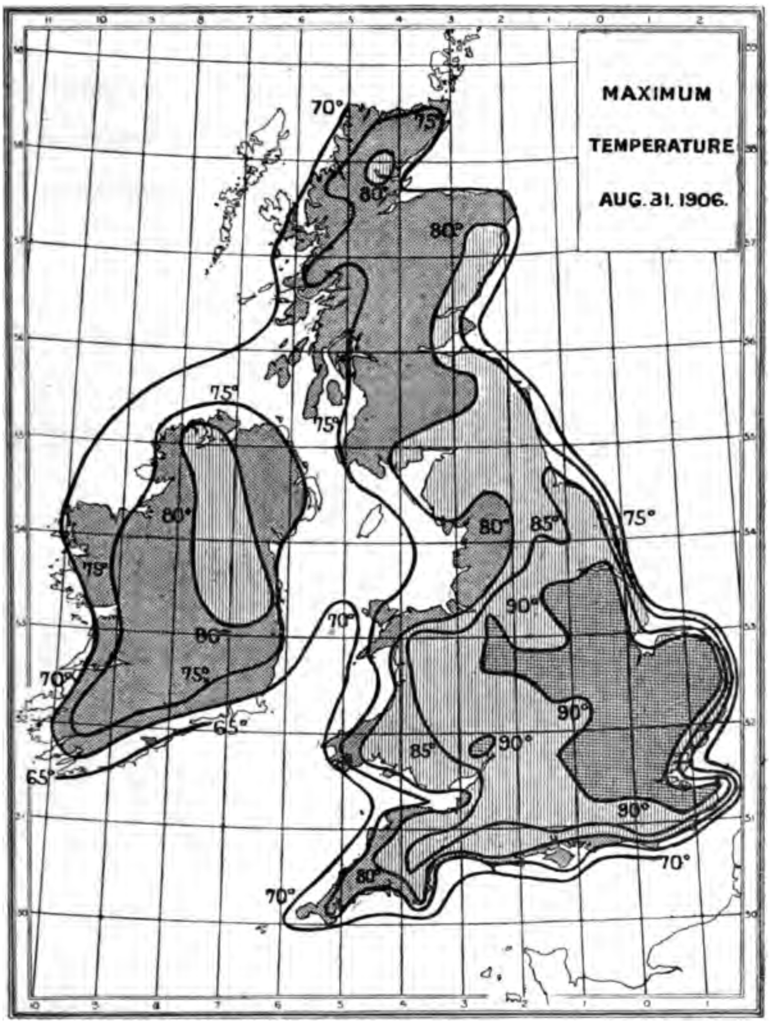

FIG. 12.

On August 31 the temperature was still higher, for 90° were recorded over the whole of the eastern part of England, and temperatures exceeding 85° were registered over the greater part of England and Wales. Temperatures over 80° were registered over nearly the whole of England and the southern and eastern part of Scotland and a large part of Ireland.

As the minimum on August 29 was low, there was a range of 50° in a period of two days.

On September 1, nearly similar conditions prevailed over England; while over Scotland, Wales, and Ireland temperatures were higher than

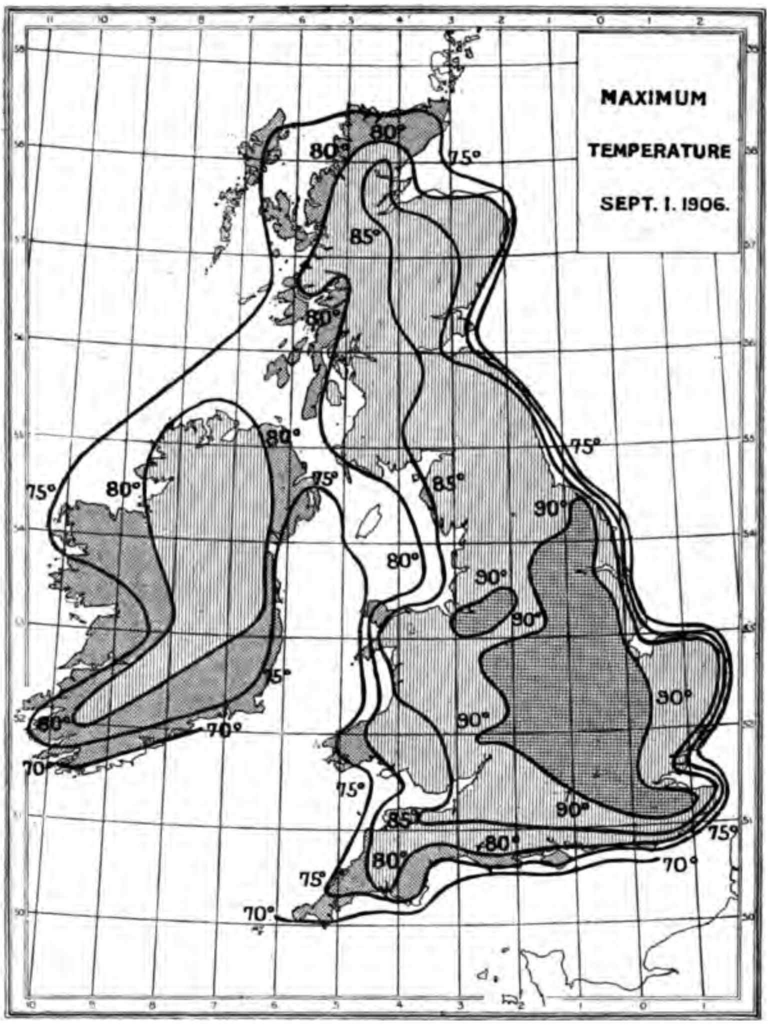

FIG. 13.

on the preceding days. This was in fact the hottest day, for temperatures of 75° and upwards were recorded in every part of the British Isles, except at the extreme coast stations.

On September 2, temperatures of 90° and upwards were again recorded over the greater part of England; while temperatures of 80° and upwards were registered over practically the whole of England, Wales, and Scotland, and a large part of Ireland.

On September 3, 90° and upwards were registered over the eastern part of England; and temperatures of 80° and upwards were registered over almost the whole of the eastern half of England. Over the western part of England and Wales, and also over Scotland and Ireland, the temperature decreased considerably, so that readings under 70° were recorded over nearly the whole of that district.

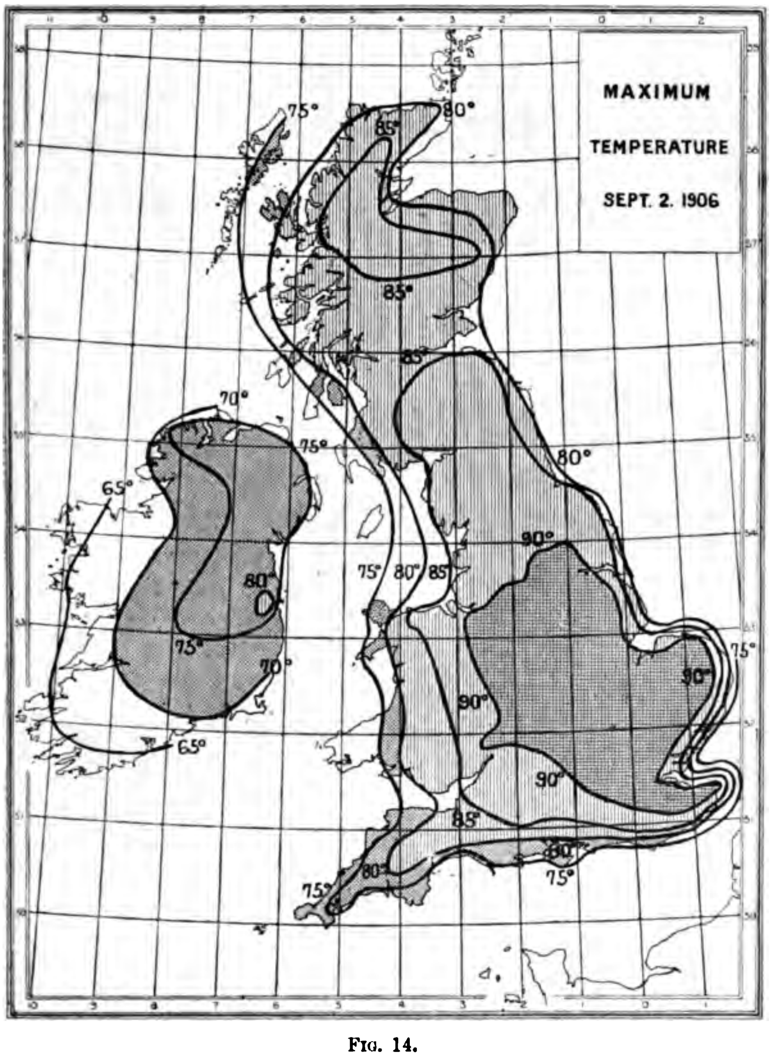

FIG. 14.

During this period the air was very clear, and consequently brilliant sunshine prevailed over nearly the whole of the country. The maps (Figs. 16-20) show the distribution of sunshine during those days, where it will be seen that twelve hours and upwards of sunshine were recorded at many stations, especially along the south and eastern counties. The five days August 29 to September 2 practically formed a "record" for prolonged duration of sunshine.

Radiation was very pronounced at this time, the solar radiation thermometer readings being very high. The nights were not cold, and high minimum temperatures were registered at the more elevated stations, *e.g.* at Addington Hills, 71°·9 on September 1, and 72°·1 on the 2nd.

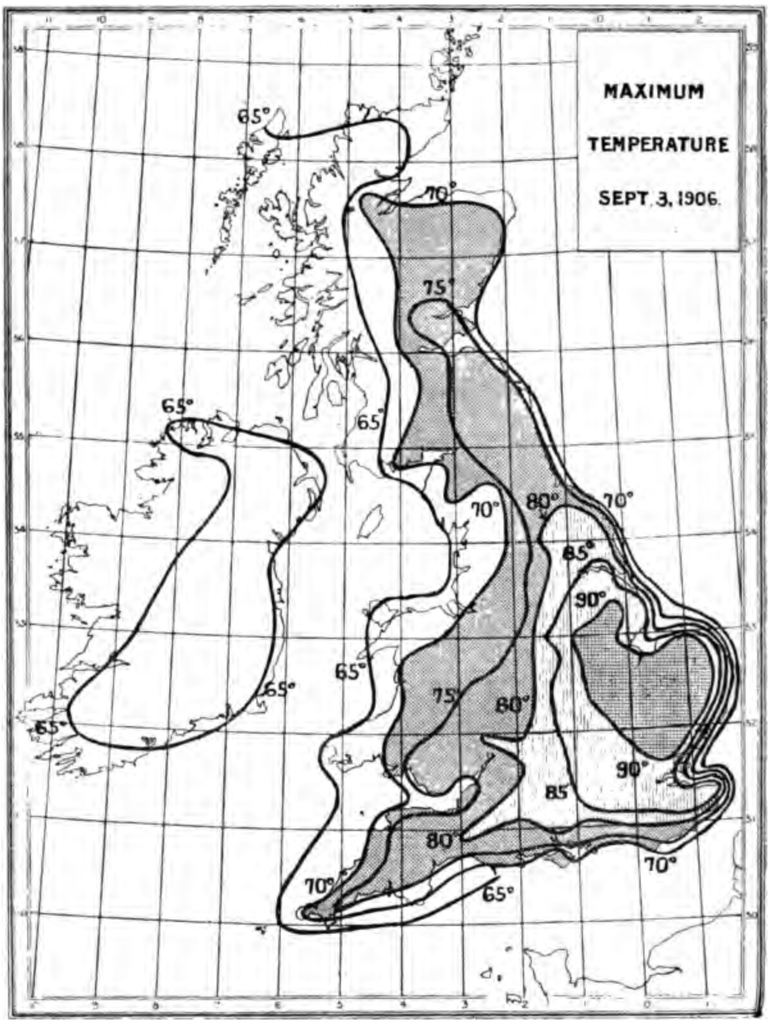

Fig. 15.

If reference be made to the *Daily Weather Charts* (Figs. 21-25), it will be seen that a large anticyclonic system prevailed over a great part of western Europe, and extended as far as the British Isles. A slight disturbance came in from the westward on September 2, and passed apparently up between Ireland and Wales and across Scotland. This caused the formation of cloud, and the consequent lowering of the temperature over those districts.

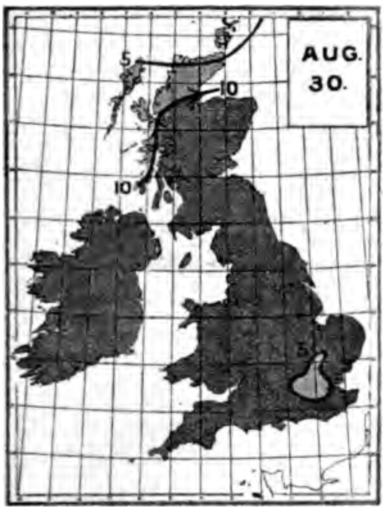

FIG. 16.—Hours of Sunshine.

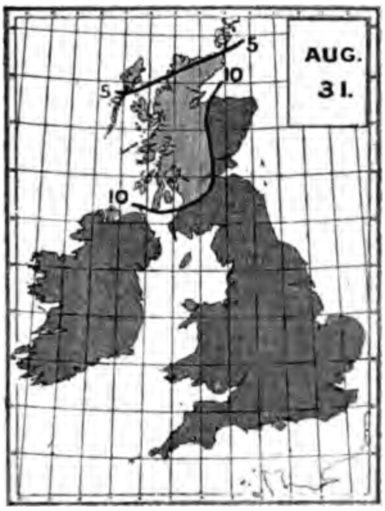

FIG. 17.—Hours of Sunshine.

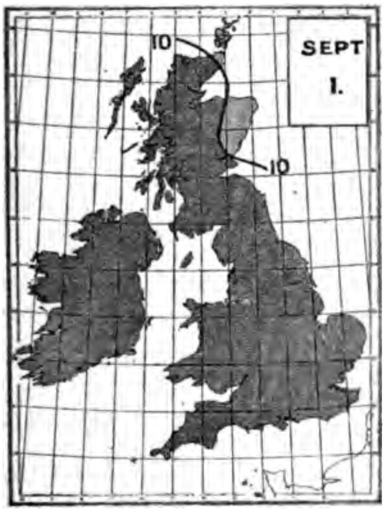

FIG. 18.—Hours of Sunshine.

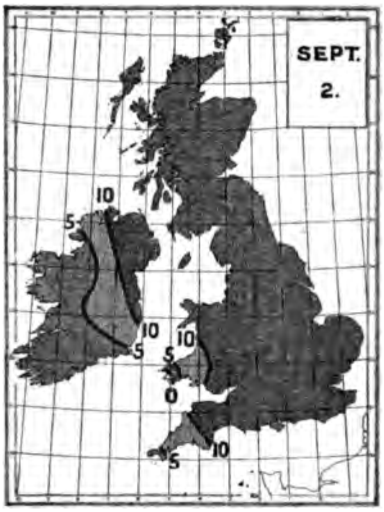

FIG. 19.—Hours of Sunshine.

Extreme Temperatures.

I do not propose to give the maximum temperatures of these days for the various stations. Probably the temperature did not go above 94°·5. One or two readings of 96° are reported, but I am of the opinion that they are too high. I will only refer to the temperatures recorded at the Royal Observatory, Greenwich.

Those above 90° were as follows:—

August 31	94°·3	September 2	93°·5
September 1	91·9	„ 3	91·0

There were thus four consecutive days with a temperature over 90°. I have not been able to find any record of readings above 90° for a similar period. Temperatures above 90° on three days in succession have only been recorded as follows:—

1868.		1876.		1893.	
July 20	90°·0	Aug. 13	92°·6	Aug. 16	93°·0
„ 21	92·2	„ 14	93·8	„ 17	94·2
„ 22	96·6	„ 15	93·1	„ 18	95·1

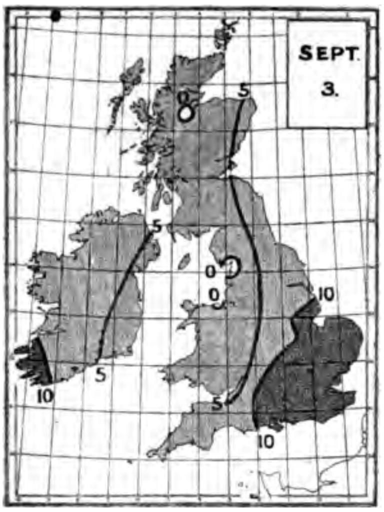

FIG. 20.—Hours of Sunshine.

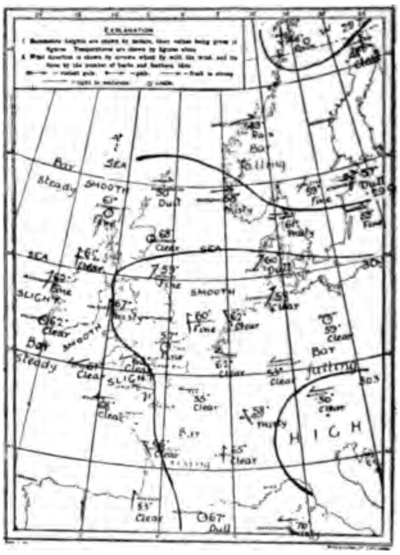

FIG. 21.—August 30, 8 a.m.

There have only been two previous occasions on which temperatures above 90° have been recorded in the month of September; these were:—

1868.	September 7	92°·1	1898.	September 8	92°·1

So the readings in 1906—September 1, 91°·9; September 2, 93°·5; September 3, 91°·0—beat the "record" in being three consecutive days with so high a value.

It may be interesting to give the whole of the instances in which the temperature of 93° and above has been recorded at Greenwich between 1814 and the present time, viz.:—

1818.	July 24	93°·5	1881.	July 15	97°·1
1846.	July 5	93·3	1884.	Aug. 11	94·2
1858.	July 16	94·5	1893.	Aug. 16	93·0
1859.	July 18	93·0	„	„ 17	94·2
1868.	July 22	96·6	„	„ 18	95·1
1876.	July 15	93·0	1900.	July 16	94·0
„	„ 17	94·0	1906.	Aug. 31	94·3
„	Aug. 14	93·8	„	Sept. 2	93·5
„	„ 15	93·1			

Great Dryness.

Another remarkable feature connected with this period was the great dryness of the air; for on September 1 and 2, at 2 p.m., differences of 25°

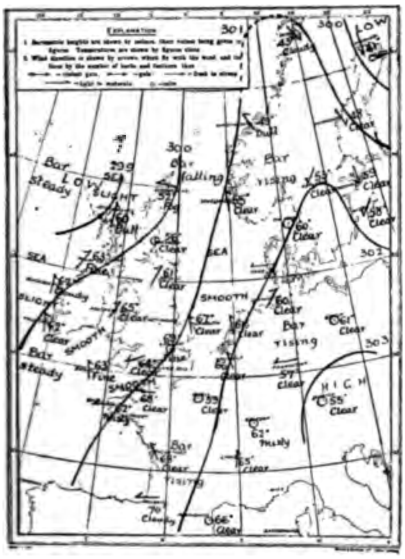

FIG. 22.—August 31, 8 a.m.

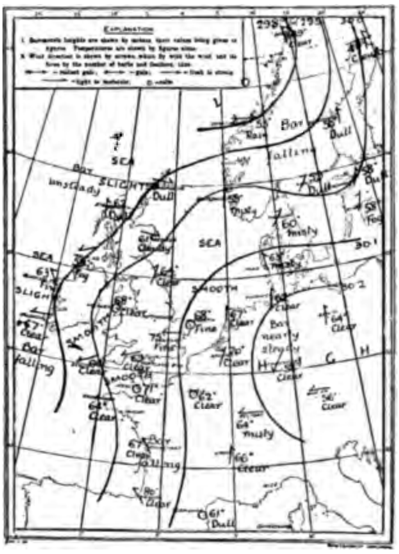

FIG. 23.—September 1, 8 a.m.

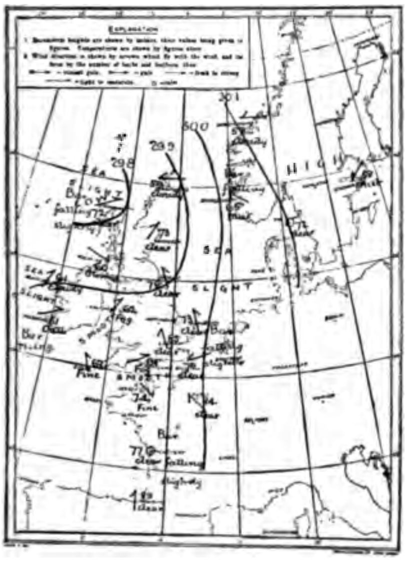

FIG. 24.—September 2, 6 p.m.

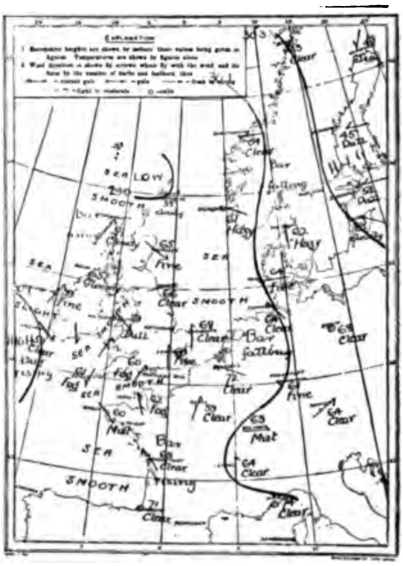

FIG. 25.—September 3, 8 a.m.

were observed between the readings of the dry- and wet-bulb thermometers, and relative humidities below 30 per cent were recorded at several inland places, while over the greater part of the country the relative humidities were much lower than usual.

In Table VI. will be found the temperature of the air, the dew point, and the relative humidity at 2 p.m. for a number of stations, from August 30 to September 3.

TABLE VI.—TEMPERATURE, DEW POINT, AND RELATIVE HUMIDITY AT 2 P.M., AUGUST 30 TO SEPTEMBER 3, 1906.

STATIONS.	August 30.			August 31.			September 1.			September 2.			September 3.		
	Temperature.	Dew Point.	Rel. Hum.	Temperature.	Dew Point.	Rel. Hum.	Temperature.	Dew Point.	Rel. Hum.	Temperature.	Dew Point.	Rel. Hum.	Temperature.	Dew Point.	Rel. Hum.
	°	°	%	°	°	%	°	°	%	°	°	%	°	°	%
Sumburgh Head	53·0	49·0	86	59·0	53·3	82	64·0	53·0	68	62·0	54·6	77	54·0	54·0	100
Stornoway .	63·0	53·7	72	63·0	55·6	77	75·0	52·6	46	70·0	55·8	61	61·0	49·8	66
Nairn . .	77·0	51·5	41	76·0	48·6	38	79·0	58·7	50	80·0	64·9	60	62·0	56·4	82
Aberdeen .	74·9	56·3	52	78·2	55·7	46	79·7	60·0	51	73·8	56·7	55	65·0	55·5	71
North Shields .	68·0	55·5	65	74·0	58·4	59	83·0	61·3	48	...	...	...	67·0	58·0	73
Spurn Head .	65·0	57·7	78	71·0	60·4	69	70·0	59·4	69	70·0	61·1	74	70·0	61·1	74
Yarmouth .	69·0	61·9	78	73·0	57·3	58	72·0	61·5	69	74·0	60·2	62	71·0	62·2	74
Hodsock[1] .	...	...	...	...	...	...	91·7	51·7	26	92·2	52·5	26	...	...	...
Nottingham .	82·3	54·3	39	91·5	63·3	40	92·1	52·7	27	92·6	52·7	26	88·3	56·6	34
Oxford[2] . .	80·5	47·9	32	88·9	56·4	34	90·3	52·7	28	88·4	52·0	29	83·0	57·9	43
Berkhamsted[1] .	82·8	53·1	36	90·9	56·2	31	90·0	52·3	28	91·9	50·9	25	85·7	55·2	35
Norwood . .	...	...	...	...	...	...	...	...	...	90·8	53·5	28	...	...	...
Kew . .	80·9	52·7	37	89·6	57·6	34	90·5	57·7	33	91·3	53·8	28	83·2	57·1	41
Dungeness .	72·0	56·2	58	77·0	60·0	56	78·0	61·1	56	80·0	61·5	53	69·0	60·1	73
Portland Bill .	66·0	62·4	88	68·0	62·6	83	67·0	63·4	88	62·0	60·1	94	62·0	58·3	88
Holyhead .	68·0	56·2	66	71·0	60·8	70	73·0	61·2	66	66·2	60·4	82	59·0	55·2	87
St. Ann's Head	69·0	58·3	69	66·0	62·4	88	67·0	59·8	78	63·0	63·0	100	62·0	60·1	94
Falmouth .	67·4	57·7	71	67·5	61·4	81	66·2	60·6	82	74·5	65·0	71	68·9	61·8	78
Scilly . .	66·0	58·8	78	68·0	60·8	78	67·0	61·6	83	68·0	62·6	83	63·0	59·3	88
Jersey . .	81·3	57·3	44	73·8	58·8	59	80·3	58·2	47	76·8	60·1	55	71·8	61·3	69
Malin Head .	67·0	59·8	78	76·0	60·6	59	83·0	63·0	51	65·0	65·0	100	62·0	56·4	82
Donaghadee .	63·0	57·4	82	67·0	58·0	73	70·0	57·6	65	65·0	61·4	88	60·0	54·4	82
Blacksod Point	68·0	55·5	65	68·0	57·3	69	76·0	58·9	55	62·0	56·4	82	60·0	52·5	76
Valencia . .	71·9	54·4	54	66·1	58·2	76	79·0	51·1	38	61·6	56·2	82	61·8	51·4	69
Roche's Point .	65·0	59·5	82	61·0	59·1	93	69·0	60·1	73	64·0	64·0	100	68·0	53·7	60

[1] At Hodsock and Berkhamsted the readings are for 3 p.m.
[2] At Oxford the reading on September 2 is for Noon and not 2 p.m.

Relative humidity values below 50 per cent for the whole of the day are so remarkable that I give herewith a list of all such as recorded at the Royal Observatory, Greenwich, between 1848 and the present time. They are as follows:—

		%			%
1855.	Dec. 20 . .	34[1]	1877.	June 29 . .	48
1865.	June 24 . .	48	1880.	May 26 . .	49
1867.	June 27 . .	48	1886.	May 6 . .	49
1868.	May 19 . .	43	1887.	June 21 . .	46
,,	June 27 . .	49	,,	July 8 . .	49
,,	July 20 . .	49	1903.	Jan. 15 . .	47
,,	,, 22 . .	49	1906.	Aug. 31 . .	42
1870.	April 20 . .	44	,,	Sept. 1 . .	47
1875.	June 5 . .	48	,,	,, 2 . .	41
1876.	Aug. 13 . .	48	,,	,, 3 . .	44

[1] Belville's observations show a relative humidity of 36 per cent at 3 p.m. on this day.

Effects of the Heat.

Owing to the intense heat, vegetable matter became very inflammable, and consequently there were more stack fires than usual; also the grass and stubble fields beside railways suffered very much. Many acres were literally blackened by ashes, doubtless sparks thrown from the passing engines falling on the intensely dry pastures and stubble fields, setting them on fire. Extensive stretches of heather and gorse in many parts of the country were also set on fire.

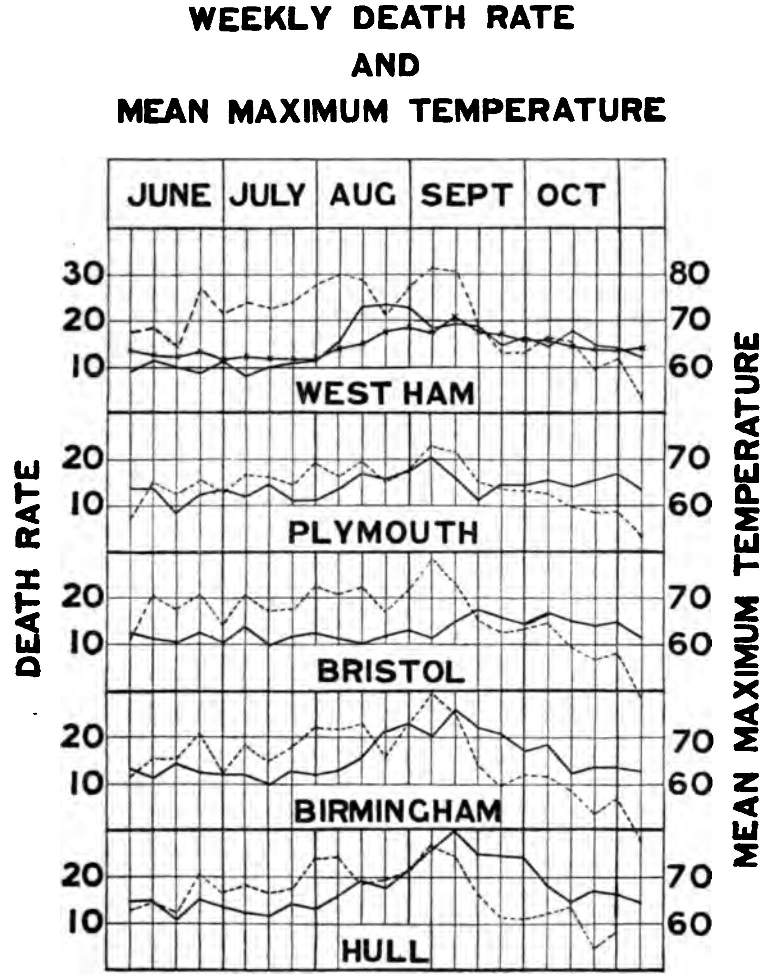

FIG. 26.

Work was suspended at many ironworks; and also at some of the factories in Birmingham operations were suspended at midday.

The football season commenced on Saturday, September 1; but owing to the intense heat some of the players were placed *hors de combat*, and at many places the matches were postponed to a later hour of the day.

Death Rate.

The death rate in London was below the average from the middle of May till the early part of August; but with the advent of the hot weather the death rate increased considerably, and was very much above the average in the week ending September 8.

As evidently temperature has a great effect upon the death rate, I have selected five large towns, and have extracted for them, from the *Weekly Returns* of the Registrar-General, the particulars relating to the death rate, and also the number of deaths of infants under one year of age. These are given in Table VII., together with the mean maximum temperatures for each week from June 2 to October 27. The data are also plotted on Fig. 26, from which it will be seen that when the mean maximum temperature for the week is below 70° there is very little effect upon the death rate; but when the mean maximum temperature for the week exceeds 72° the death rate at once begins to rise (after an interval of one to two weeks).

[In Fig. 26 the smoother thick line represents the death rate for the whole of London, and the other line the death rate for West Ham.]

TABLE VII.—MEAN MAXIMUM TEMPERATURE, DEATH RATE PER 1000, AND TOTAL NUMBER OF DEATHS OF INFANTS UNDER ONE YEAR OF AGE IN EACH WEEK, JUNE 2 TO OCTOBER 27, 1906.

Weeks ending	West Ham (Pop. 301,617).			Plymouth (Pop. 118,014).			Bristol (Pop. 363,223).			Birmingham (Pop. 548,022).			Hull (Pop. 262,426).		
	Temperature.	Death Rate.	Infants.	Temperature.	Death Rate.	Infants.	Temperature.	Death Rate.	Infants.	Temperature.	Death Rate.	Infants.	Temperature.	Death Rate.	Infants.
June 2	67·4°	9·2	12	57·2°	13·7	7	61·1°	12·6	15	61·7°	13·3	37	62·9°	14·5	17
,, 9	68·6	11·4	16	65·0	13·7	4	70·6	11·2	14	65·5	11·5	30	64·3	14·7	16
,, 16	64·6	10·0	10	62·4	8·4	6	67·7	10·3	17	65·5	14·4	35	62·3	10·9	13
,, 23	76·8	8·8	15	65·4	12·4	1	70·8	12·6	13	70·8	12·7	28	70·7	15·1	17
,, 30	71·5	11·4	11	62·5	13·3	5	64·3	10·5	8	62·8	12·2	30	66·7	13·3	20
July 7	74·0	8·1	10	66·7	11·9	3	70·5	13·9	13	68·5	12·1	28	68·1	12·1	11
,, 14	72·8	10·4	13	66·0	14·6	5	67·3	9·8	14	65·1	10·0	25	66·4	11·5	12
,, 21	74·2	10·9	10	64·3	11·0	7	67·5	11·5	17	68·0	13·0	31	67·6	14·3	10
,, 28	77·8	11·6	22	69·1	11·0	4	72·9	12·5	12	72·2	12·0	34	74·0	13·1	21
Aug. 4	80·1	15·4	34	66·3	13·7	11	70·8	11·2	22	71·8	12·9	44	74·3	15·9	32
,, 11	78·8	23·0	72	69·6	16·8	12	72·4	10·3	21	73·0	15·5	63	68·6	19·3	46
,, 18	71·3	23·5	85	65·1	15·5	11	67·1	11·9	30	66·1	21·3	107	69·6	17·7	51
,, 25	77·4	22·8	63	67·7	17·2	18	71·8	13·2	31	73·1	22·9	130	71·3	21·7	52
Sept. 1	81·6	18·3	62	73·0	20·3	23	78·6	11·6	37	79·5	20·3	94	76·9	25·8	67
,, 8	80·9	19·4	46	71·9	15·9	18	73·3	14·9	44	75·1	26·0	140	74·7	29·8	78
,, 15	69·1	18·7	46	65·1	11·0	12	65·5	17·4	53	64·4	22·1	123	66·6	25·0	53
,, 22	63·2	14·7	41	63·7	14·6	11	62·9	15·8	45	59·8	20·8	115	61·4	24·6	63
,, 29	63·1	16·6	36	63·2	14·6	9	63·6	14·5	31	62·1	17·1	69	61·0	24·2	57
Oct. 6	66·5	14·3	27	62·5	15·5	10	64·8	16·9	36	61·7	18·5	59	62·3	18·3	30
,, 13	65·5	17·8	27	59·8	14·1	7	59·5	15·1	22	58·7	12·6	38	63·6	14·7	21
,, 20	59·4	14·7	26	58·6	15·5	10	56·9	14·1	20	53·9	13·7	42	54·9	16·9	22
,, 27	61·7	14·2	35	58·8	16·8	3	58·2	14·9	21	56·7	13·8	40	58·1	16·3	21

It will be seen that at West Ham the maximum death rate occurred in the weeks ending August 11 to 25, whereas at the other places the maximum death rate occurred in the first to the third weeks of September. This is apparently due to the temperature in the neighbourhood of London being much higher in the early part of August than it was in the other parts of the country. The greatest rise in the death rate occurred at Hull, the maximum being reached in the second week of September. This is no doubt due to the prolongation of the intense heat over the eastern part of the country in the period August 29 to September 3.

With regard to the death rate, the increase is made up almost entirely of infants under one year of age; fully half the total death rate being made up by infants. This, no doubt, is due to the prevalence of epidemic diarrhœa, which evidently sets in when the mean maximum temperature for the week rises above 72°.

Table VIII. gives the death rate per 1000 living from diarrhœa for a number of the large towns, for each week from August 4 to September 29, and also the annual death rate for the summer quarter (consisting of the thirteen weeks, July 7 to September 29), together with the difference from the average of the preceding ten years.

TABLE VIII.—ANNUAL DEATH RATE PER 1000 LIVING FROM DIARRHŒA IN EACH WEEK, AND ALSO FOR THE THIRD OR SUMMER QUARTER.

Town.	August.				September.					July 7–Sept. 29 (13 weeks).	
	4	11	18	25	1	8	15	22	29	Annual Rate.	Diff. from Average.
Croydon . .	0·7	1·4	2·1	4·5	4·1	9·7	7·6	5·2	3·5	3·1	+0·9
West Ham .	3·5	10·2	14·0	11·4	9·9	7·8	8·6	7·1	3·3	6·1	+1·3
Leyton . .	4·4	4·4	11·5	7·1	6·6	7·1	3·1	2·2	0·9	3·8	+0·5
Walthamstow	2·6	3·4	7·3	8·6	7·3	6·4	7·3	5·2	5·2	4·2	+0·7
Brighton . .	0·4	0·4	1·6	1·2	3·7	2·8	5·7	3·3	3·3	1·7	−0·8
Portsmouth .	1·3	2·5	5·3	5·6	5·6	8·9	10·4	5·6	3·1	3·9	0·0
Southampton	...	1·3	1·8	1·3	5·3	8·4	7·6	7·6	2·7	2·8	+0·2
Norwich . .	2·7	4·9	7·5	4·0	9·3	10·2	13·7	6·6	4·4	5·3	+1·6
Plymouth .	1·8	2·7	3·1	3·5	4·9	5·3	4·4	3·1	2·2	2·4	−0·5
Bristol . .	0·3	0·1	1·6	2·2	2·0	3·3	3·9	3·3	1·4	1·5	−0·2
Birmingham .	1·8	4·3	8·2	10·8	8·1	10·3	10·4	7·7	4·9	5·3	+1·1
Leicester . .	0·7	2·0	4·0	7·2	7·6	10·3	6·5	6·7	2·0	3·7	−0·5
Nottingham .	1·6	6·6	4·7	10·9	9·6	10·2	10·7	7·4	3·1	5·1	+1·3
Liverpool . .	2·3	4·1	7·8	8·9	9·2	12·3	10·3	7·2	6·3	5·5	+0·5
Bolton . .	0·6	1·4	5·5	4·0	3·5	7·8	7·2	7·5	3·2	3·3	−0·4
Manchester .	1·4	2·8	6·5	8·1	8·1	11·0	10·6	7·0	5·0	4·8	+0·6
Blackburn .	0·8	...	...	0·8	0·8	6·6	5·4	8·2	5·1	2·2	−0·2
Halifax . .	...	0·5	...	...	0·5	1·0	1·9	1·9	1·0	0·5	−0·4
Bradford . .	0·7	1·3	4·5	3·1	3·8	8·5	8·9	4·5	2·7	3·1	+0·7
Leeds . . .	3·0	3·9	5·7	4·7	5·7	5·1	5·8	3·3	2·2	3·3	−0·1
Sheffield . .	2·9	4·7	5·6	9·0	9·2	13·9	11·6	8·5	6·5	5·7	+0·7
Hull . . .	2·0	4·6	7·0	7·7	9·3	10·1	11·1	8·1	6·8	5·2	+0·1
Newcastle .	0·6	1·0	2·1	1·9	4·7	3·7	6·6	8·3	8·0	2·9	+0·6

It will be seen that the deaths from epidemic diarrhœa first occurred in those towns where the mean maximum temperature for the week reached 72°. One remarkable feature in this Table is the smallness of the death rate at Halifax. This possibly may be due to the fact that that town is 600 ft. above sea-level, and consequently the temperature would be proportionately lower than at places at a lower level.

A complete discussion of the number of deaths from epidemic diarrhœa in connection with atmospheric conditions, especially temperature, is well worthy of being taken up.

Dr. J. Priestley, the Medical Officer for the Borough of Lambeth, has kindly sent me the following particulars:—

"It is found that when the 4 ft. earth temperature reaches 56° and over, epidemic diarrhœa amongst infants becomes exceedingly common, and infants die off in large numbers. It is probable that some germ or poison is set free at that particular 4 ft. earth temperature, and may be conveyed into infants' bodies either through food or through air. As the 4 ft. earth temperature again falls and reaches 56°, the infantile diarrhœa cases gradually disappear. Along with the increase of the 4 ft. earth temperature there is, as you know, a corresponding increase in the mean temperature of the air. Rainfall also plays an important part, in that a dry season increases the number of these deaths from infantile diarrhœa. A high mean air temperature, a 4 ft. earth temperature of 56° (and upwards), and a dry season ensure a very high mortality (amongst infants chiefly) from epidemic diarrhœa. Whereas a low mean air temperature, a 4 ft. earth temperature of less than 56°, and a wet season are followed by a very small number of such deaths.

"I do not think it is a matter of the milk going sour during the hot weather, but rather a question of the milk becoming infected with the germ, or poison, which is only developed, or, at least, which only becomes dangerous to health, when the temperature rises above 60° (air temperature) and 56° (4 ft. earth temperature).

"The weather this year has been most conducive to an increase of deaths amongst infants, but the corrected statistics are not yet to hand, though I am informed that the infant mortality rate (speaking generally) is not so high as was to have been expected. It would almost seem that the preventive measures being taken by sanitary authorities are beginning slowly to bear fruit, viz. the visiting of houses wherein births have occurred, greater municipal cleanliness (generally speaking), and the provision of municipal milk depôts."

Milk and Tinned Foods.

As a high temperature has the effect of turning milk sour and rendering it unfit for drinking purposes, I have made inquiries on the subject; and Mr. C. F. Thwaite of West Norwood informs me that the losses from milk turning sour, owing to the heat, were very much reduced through the system of pasteurising and cooling which is largely done now, sometimes (but very rarely) at the farm, but more often immediately on its arrival at the premises of the retailer. The milk is first raised to a temperature of 150°, and then immediately cooled at the rate of 100 gallons an hour, down to 50°. This enables the milk to keep twelve hours longer than it otherwise would in the hottest weather. With regard to the temperature fatal to milk, Mr. Thwaite thinks anything above 70°, and kept at that temperature, would soon turn milk sour; but at 60°, if it can be kept at that temperature or below, is a fairly safe degree.

Not only was the milk a source of danger to infants during the hot weather, but the great use which is now made of tinned foods would produce ptomaine poisoning and cause diarrhœa.

Harvest and Milk Supply.

Owing to the extremely fine weather, the corn harvest was, on the whole, gathered in less time than usual. Mr. S. Egar of Wryde, near Peterborough, informs me that the harvest in the Fens commenced the first week in August, and was practically finished by September 8.

Work proceeded with practically no interruption; and as most of the corn stood up well, it was able to be cut by the aid of self-binding machines, and so gathered in much more rapidly than if done by day labourers.

Owing to the drought, "keeping" for cattle was very deficient, and artificial food was largely resorted to. Many meadows were grazed which under ordinary circumstances would have been mown. Second crops of clover were light, and mostly grazed.

The drought had a very serious effect upon the milk production in the Midlands, the east, south-east, and south of England, the shrinkage amounting to as much as 30 per cent.

Flowers, Trees, etc.

Mr. E. Mawley has favoured me with the following particulars respecting the Rose Shows during the past summer:—

"All three exhibitions of the National Rose Society were more or less injuriously affected by the dry weather. The first show, which was held in the Royal Botanic Gardens, Regent's Park, on July 5, suffered much less than the other two, owing to the welcome and heavy rains at the end of June. The number of exhibits proved exceptionally large, but, on the other hand, the general quality of the individual blooms was decidedly below average. At the Provincial Show, which took place at Edinburgh on July 18, several of the leading rose nurserymen, as well as a good many amateur exhibitors, were unable to compete. By the time of the autumn show, which was held in Vincent Square, Westminster, on September 19, the further growth of the plants had in many parts of the country almost ceased; with the result that that exhibition proved a singularly small and unrepresentative one.

"In my garden at Rosebank, Berkhamsted, roses made scarcely any growth after the middle of July. In fact, both in the kitchen and flower garden, vegetation remained almost at a standstill from that time until wet weather set in at the beginning of October.

"In a prolonged drought like this the paralysing effects of a continued dry atmosphere, accompanied by an exceptional duration of bright sunshine, appears to be more trying to most plants than the actual want of moisture at their roots."

Dr. C. P. Hooker of Cirencester has also sent me the following notes:—

"Here I noted many trees, though not the largest, dropped their leaves altogether, and yet on the whole the foliage is later than I ever knew it; many elms and oaks are still as green as at midsummer. I fancied birds were unusually late moulting, certainly the thrush and blackbird were, and I heard no thrush sing till October, quite a month later than usual (perhaps they missed their usual food of worms, etc.). Late second or third nests were common too. I saw young goldfinches the second week of September. Our river is still dead low, though several springs have risen."

Letters appeared in the newspapers a few weeks ago stating that grapes had been fully ripened this year in London, which had not occurred for many years past. This evidently was due to the great heat and brilliant sunshine being prolonged through the late summer and far into the autumn.

Holiday Traffic.

The effect of the brilliant sunshine and warm weather upon the holiday traffic may be gathered from the following particulars:—

Mr. J. Stokes informs me that nearly 20,000 more passengers than in the previous year were landed at Margate Pier by the London steamboats; and also that out of 1200 outdoor entertainments at Margate only about 6 were missed owing to bad weather during the season, nine or ten entertainments being run daily. The money takings by the Fête Committee were consequently much in excess of the previous year.

The number of visitors to the Isle of Man during the past summer exceeded all records, being between 30,000 and 40,000 in advance of last year's figures.

At Yarmouth, the Town Clerk informs me that there was a much larger number of visitors than usual, and that the season was lengthened by the fine weather. None of the outside entertainments were interfered with by bad weather; and bathing was carried on to a later date in the year than usual.

Dr. F. J. H. Coutts, Medical Officer for Blackpool, informs me that "during August the town was very full with an exceptionally large number both of day trippers and staying visitors; while September showed a phenomenal record. I heard of lodging-houses, not on the front or in the best position, which towards the end of the month were so full that they could not take in other visitors. I heard of a case where the family had been accustomed to come down in September, and had not engaged rooms beforehand. When they arrived, they found all the rooms booked in the lodging-house where they had usually obtained admission in previous years; and they found other lodging-houses in the neighbourhood similarly full."

Mr. J. H. W. Biggs of Windermere and Mr. A. M. Dawson of Keswick have favoured me with particulars with regard to the visitors to the Lake District. It appears that there is a general consensus of opinion that this has been a more than usually prosperous season—that there were far more visitors, and they were considerably above the average during July, August, and September. Although the first part of August was wet, this did not interfere with the numbers coming, and certainly visitors stayed in considerable numbers quite to the third week of September. The Furness Railway ran cheap steamer, rail, and boat trips from Fleetwood to Barrow, Lakeside, Ambleside, Coniston and back, and these took many thousands of visitors. There was a considerable accession this year to the young people camping out, which of late years has become a feature in the neighbourhood of Keswick.

Cricket.

Mr. C. W. Alcock, the Secretary of the Surrey County Cricket Club, Kennington Oval, informs me that he does not think that a cricket match had to be abandoned in 1906 through rain. It was a wonderful season for weather, and the attendances were excellent.

The following figures of 100 runs or more scored at Kennington Oval during the seasons 1905-1906 will no doubt be of interest:—

	1905.	1906.
First XI. Matches	15	24
Second XI. Matches	3	2
Club and Ground Matches	4	6
Extraneous Matches	3	6
	25	38

Thirteen more this year than last.

Mineral Waters, etc.

There was a great demand for mineral waters during the spell of hot weather. I am informed that the increase in the sales of one large Company in London was 35 per cent. This increase, however, does not apply to the whole country, but only to those districts where the temperature was so abnormally high.

Messrs. Ind, Coope & Co. of Romford inform me that for their two breweries they could say that during the hot weather their output was considerably increased over the same period of last year.

With regard to the Burton breweries, which supply all parts of the country, the tale is different, for the impression is that weather which conduces to the increase of sales of beer is that of moderate temperature; abnormal cold or unusual heat both militate against beer-drinking. In the former case the public to a great extent have recourse to spirits instead of ale, and in the latter to non-intoxicating aerated drinks or liquids which they consider of less alcoholic strength, such as cider.

As a consequence of the drought and hot weather, the walls and ceilings of many houses cracked owing to the settlement of the foundations.

Conclusion.

The dominating factor of the weather of the past summer was the high barometer. The large anti-cyclonic area came further to the eastward than usual. It would be interesting to discover whether in any other parts of the world there was a diminution of pressure prevailing at the same time. Possibly now that telegraphic communication has been established with Iceland, we may be able to form some idea as to the conditions which are likely to prevail during a coming season.

PUNCH, OR THE LONDON CHARIVARI.—SEPTEMBER 19, 1906.

BERNARD PARTRIDGE.

AU REVOIR!

MR. PUNCH (to SUMMER). "MUST YOU GO, MY DEAR? THE MOST CHARMING VISIT I EVER REMEMBER!"

FIG. 27.

On examining the daily weather maps for previous years I find that somewhat similar barometric conditions prevailed when very high temperatures were recorded. I find also that during the great frosts which occurred in December 1879, January 1881, and February 1895, the distribution of barometric pressure was somewhat similar to that of the present summer. No doubt the air under these conditions is very suitable for great radiation, and so high temperatures occur with an anti-cyclone in summer and low temperatures in winter. An investigation into these matters would, I am sure, lead to some interesting results.

From what has been said in this paper, it will be evident that the weather during the past summer was of a very exceptional character. Whatever deleterious effects it may have had, we in England can say that it was a very brilliant and enjoyable one; and we can fully endorse the sentiment expressed in Mr. Bernard Partridge's cartoon in *Punch*, bidding farewell to the summer, and wish it *Au revoir*. (By permission of the Proprietors of *Punch* this cartoon is reproduced in Fig. 27.)

I have not given any monthly means of temperature, barometer, etc., in this paper, as these will be found in due course in the *Meteorological Record*, in the *Monthly Weather Report*, and in *Symons's Meteorological Magazine*.

I must express my thanks to all those who have so kindly favoured me with information, and especially to Dr. Shaw for permitting me to use the observations supplied to the Meteorological Office, and to Dr. Mill for furnishing me with the maps of monthly rainfall. I have also to thank all the members of the staff for the cheerful and ready assistance which they have given me in the compilation of the statistics and in the preparation of the diagrams used in this paper.

DISCUSSION.

Dr. W. N. **Shaw** remarked that the paper was so comprehensive that very little remained to be added. He was glad to notice that the maps referred to the British Isles as a whole. It was interesting to see how the areas of high temperature and low rainfall were localised. It would be well to follow Mr. Marriott's suggestion to find out, by extending the area under review, whether any compensation for the exceptional amount of sunshine existed, and if so in what places. With reference to the use of the word "wave," he wondered whether the area of great heat intensity passed from these islands over parts of the Continent as a wave in the true sense, or simply disappeared. With regard to the comparison of the temperature with the death rate, it was understood, he thought, that the temperature of the soil was of great importance. Geography would also make a certain amount of difference. The Medical Officer of Health for Nairn had sent him a report of the quarterly returns of mortality from July to September, which showed no deaths under forty years of age in the three months. Not one infant was entered on the death rate returns for that quarter.

Mr. W. H. **Dines** considered Mr. Marriott's remark about the death rate very interesting. Some years ago he had come to the same conclusions when working at the subject. He took the mean temperatures, not the maximum temperatures. So long as the mean temperature was under 60°, he found it did not much matter what it was. Regarding Dr. Shaw's remarks about the north of Scotland, probably the temperature at Nairn, even in an exceptionally hot summer, did not reach the point affecting health. The connection between the death rate from diarrhœa and heat was perfectly well known ; but even if diarrhœa were cut out of the returns, an increase in the general death rate nearly always accompanied a high summer temperature. He could hardly look upon a hot summer as a matter for congratulation, since it produced some ten to twenty thousand additional deaths. He must thank Mr. Marriott for a most interesting paper.

Mr. F. J. BRODIE fully concurred in the popular verdict as to the unusual fineness of the past season, but was scarcely prepared to agree with the author in his somewhat free use of the terms "exceptional" and "remarkable." The spell of warmth experienced at the close of August and the beginning of September was undoubtedly of a phenomenal character, and appeared in many ways to have beaten all previous records. The early part of the summer was, however, distinctly cool, and at one time surprise was freely expressed that so much bright sunshine should have been accompanied by a striking absence of anything in the shape of intense summer heat. With regard to the season as a whole, as included within the three months June, July, and August, an examination of the records published in the *Weekly Weather Report* of the Meteorological Office failed to reveal the existence of features of anything like an extraordinary character. Taking a summary of the figures for the various English districts, it would appear that the mean temperature of the summer was not so high as in 1901, and not nearly so high as in 1899. In some individual districts it was lower than in several recent years. The summer was certainly a dry one, especially in the south-eastern segment of England, where long periods of fine weather were interspersed by rains of a thunderstorm character, which occurred, as is so commonly the case, in heavy local plumps. Taking the country and season as a whole, the summer was not nearly so dry as in 1899, and in some districts it was not so dry as in 1901. With regard to the bright sunshine, the season could scarcely be classed as remarkable, inasmuch as the duration of that element was smaller than in 1904 or in 1901, and much smaller than in 1899. In the large district representing the south of England, the summer of 1899 had 160 more hours of bright sunshine than that of 1906, and in the Channel Islands it had 190 more. An interesting feature in the character of the past season, already noted by Mr. Marriott, was the frequent prevalence of thick fog around our western and southern coasts. This phenomenon may have been due to an unusual coolness in the temperature of the sea surface, a fact remarked upon by some of the numerous swimmers who attempted to cross the Channel. The connection between the prevalence of high summer temperatures and an increased death rate from bowel complaints was clearly shown many years ago by Dr. Buchan and Sir Arthur Mitchell. Excessive warmth affected both the very young and the very old—in fact those sections of the community in which the state of vitality is naturally low.

Capt. M. W. C. HEPWORTH thought those present might like to hear something about the temperature of the surface of the North Atlantic during July, August, and September. During July there was a belt of warm water stretching right away from the Gulf Stream across the Atlantic to Europe, penetrating the English Channel, but not extending farther north near our islands. This belt of warm water was cut off between the thirtieth and fortieth meridians by cold water in the earlier half of August. In the second half of August it was continuous, and the warm current reached right across, having a difference from the normal of about 2° to 3°. In September it not only reached right across the North Atlantic, but extended right up to 60° N., which is as far north as observations are available, and from about 25° E. to the eastward, so that our islands were surrounded by warm water. In this connection he would mention that in July the South-east Trades were stronger than usual. He (Capt. Hepworth) had selected an area,[1] and taken observations from this area as criteria. For this area 122 observations gave a mean velocity of the wind of

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[1] Area spoken of from Equator to 30° S., 10° E., to W. and N.

14·1 miles per hour in last July, and from observations collected in past years, about 8200, the result for July was 15·6 miles per hour—that is to say, about a mile and a half velocity in excess of the normal. This does not seem a great excess, but it is in reality a good deal for the Trades. For August last a sufficient number of observations are not at hand for comparison with normal results. This freshening of the South-east Trades, by increasing the velocity of the equatorial current, had borne a larger volume of warm water into the Atlantic, which, crossing the Atlantic, extended to our shores. This must have affected the weather in Europe, and in the British Islands especially.

Mr. W. W. **Bryant** said, referring to Mr. Brodie's remarks, that between May 8 and August 21 there was no day on which the maximum temperature at Greenwich was even the second highest for the day in 66 years' registers. August 21 was the second highest. August 22 was the second highest. August 30 was the second highest in the 66 years. August 31 was a "record," and September 1, 2, and 3 were "records." There was a second highest on October 11. October 21, 22, and 23 were "records." There was a second highest on October 24, the highest for the day having been in 1849. That day (November 21) was the highest since 1848.[1]

Mr. F. **Druce** referred to the remarkable thunderstorm of August 2. About that time the moon was full, and the extraordinary display of lightning with the full moon was very effective. Not much rain fell, and all in a short time, and in London the effect of the lightning and moonlight together on the wet streets was remarkable. Regarding the high temperature of August-September, he would like to know why the extreme temperatures should have come at that late period of the season. As to the distribution of pressure, he could not say, from a casual survey of the maps, that there was anything very special about it. He thought that high pressure must have occurred over the Continent several times previously in the summer, when the wind (South or South-east) coming off the hot and dry land would raise the temperature. He could only assume that there must have been some difference in the distribution which was not seen in the ordinary maps which would fully account for this great heat.

Mr. H. **Southall** remarked that no allusion had been made to the effect of the heat upon plant life and vegetation in general. He agreed with the conclusion that this had been an exceptional summer, yet there had been so few days in which the temperature had reached 80°. Some plants blossomed very late, and required a good deal of heat in order to bloom at all. He did not remember an instance of any of these plants blossoming at all this year. The rainfall for the three months July to September had been little more than half of the lowest rainfall recorded in the district for 89 years. He thought that the very dry season had retarded the growth of plants. Mr. Mawley had stated the effect upon roses, which he believed had not been favourable to growing plants.

Dr. H. R. **Mill** joined in the expression of thanks to Mr. Marriott for his paper. Regarding the colouring of maps expressing variations in a single condition, he wished to lay stress on the method of tinting in shades of the same colour, or passing in natural gradations from one colour of the spectrum to another. He adduced the colouring in the *Climatological Atlas of India* as an example of the best work of this kind. At Camden Square the 4 ft. earth thermometer was above 56° from early in June to October 17, an unusual length of time. Regarding Dr. Shaw's observations at Nairn, he suggested that the soil might have had something to do with it. There must be a considerable difference between a light sandy soil, as that at Nairn, and the dense clay soil of London.

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[1] The day following the meeting (November 22) produced a maximum reading, 60°·3, which is an absolute "record" for the last fortnight in November; the only previous instance of a reading exceeding 60° later in the year than November 16 having been 62°·4 on December 10, 1848.

Mr. W. **Marriott** thanked all those who had taken part in the discussion for their expressions of approval of his paper. Mr. Bryant had told them that there had been at Greenwich many "records" in temperature. The mean temperature was not high in June or July, but in the latter part of the summer the greatest effect was experienced ; and the prolongation of the warm weather into the late summer and early autumn had been one of the salient features of the summer. Mr. Druce had spoken about the high temperature taking place so late. One of the chief features during the summer was the great height of the barometer. In September it was a quarter of an inch above the average. There were only four other instances of such high value. It would be interesting to investigate this distribution of atmospheric pressure, and see whether when the barometer is so much above the average there is a greater clearness of the air, and consequent radiation, so that we get higher temperatures. In winter, with anti-cyclonic conditions we get great radiation, and consequently sharp frost. In summer, with a high barometer we get high temperatures, with conditions favourable to radiation. One special feature connected with the spell of intense heat at the end of August and the beginning of September was the dryness of the air. If during that period of heat there had been "close" weather and the amount of moisture present in the air had been much higher than it was, they would all have felt very uncomfortable, and it would have had a great effect upon the death rate. The great dryness had rendered the heat much more bearable than if the air had been very close. The question of temperature is important with regard to health and the death rate. If the town is at a high altitude, the temperature would be correspondingly lower than at sea-level. The Halifax death rate is very low, possibly because Halifax is at a considerable altitude. Mr. Brodie had referred to the temperature of the sea being below the average. With regard, however, to Channel swimmers, they reported the temperature of the water very favourable, and bathing had been carried on much longer than usual. He could have gone into the question of temperature of the soil at 4 ft., but came to the conclusion that the air temperature was the more important element to consider.

The President (Mr. **Richard Bentley**) remarked, amongst other indications of this exceptional summer, that in the neighbourhood of Windsor bright sunshine was recorded from May 22 to September 19 for no less than 119 days without any interruption. In 1901 there was a long spell of 105 days in succession ; but the sunshine fell as low as 35 consecutive days in the summer of 1902. An interesting feature during the five very hot days referred to was, that there was no gradual change in the pigmentation of the leaves, but a very sudden change took place in a few hours after the heat had diminished on September 4. On the 3rd the leaves were dark green, and on the 4th pale lemon or brown. The deciduous trees quite changed their aspect in that short time. He had heard with regard to the death rate either of Halifax or Huddersfield, that owing to the high rate of mortality among infants, the Mayor had offered a premium of £1 for each infant attaining the age of 365 days ; and this had caused a remarkable diminution of infantile mortality, and so affected the death rate abnormally. The President wished, on behalf of all present, to thank Mr. Marriott, not only for the large collection of valuable statistics contained in his paper, but also for the pleasant manner in which it had been given, and for the preparation of the numerous diagrams, which greatly added to the interest.

THE GUILDFORD STORM OF AUGUST 2, 1906.

By Admiral JOHN PEARSE MACLEAR, F.R.G.S., F.R.Met.Soc.

[Read December 19, 1906.]

The storm which burst over Guildford on August 2 shows some very curious and interesting features, in the remarkable violence of the wind, rain, and hail, within a small area, and the suddenness with which it burst. It seemed difficult at first to give it a descriptive name, but I think it has the features of a "line-squall."

On the evening of that day the whole of the south of England was an area of thunderstorms, with heavy rain and hail, and with continuous, vivid lightning from cloud to cloud, but not, apparently, from cloud to earth, indicating that the cause of the storm lay at a great height above the earth. I propose to deal with the exceptional belt of violence of this storm lying between Grayshott on Hindhead, Godalming, Guildford, and Ripley, 5 miles north-east of Guildford, where it seems to be lost in the general *mêlée* of thunderstorms from west, south-west, and south-east, which appears to have existed about London from 8.45 to 10 p.m.

When I began collecting data to trace the origin and limits of this storm, I thought I could trace it from the coast near Havant, north-east to Epsom; but after a study of the many reports received, I do not think that such a chain can be established. The area under disturbance was very extensive, and the lightning and rain appeared in so many places far apart at about the same time, that I cannot say there was a definite line-squall, though there does seem to have been a connected line of vivid lightning and heavy rain along that line, from south-west to north-east, from Emsworth to Ripley.

Confining, then, my own remarks to the belt of extreme violence mentioned above, from Hindhead to Ripley, I think, however, that a study of the atmospheric conditions prevailing over the south of England on that evening would be most instructive, and hope that the subject may be dealt with by Mr. Lempfert, who has so ably dealt with the line-squall of February 8, 1906, and who can avail himself of the reports and barograms from many stations on that evening.

Although my subject is the Guildford section of the storm, I think it well to refer first to the region south-west of it, where there were similar manifestations, especially about 3 miles east of Petersfield. At Ditcham Park, Mr. Cave reported a thunderstorm at 8 p.m., in which 0·72 in. of rain fell in 20 minutes.[1] At Emsworth, Mr. Christie reported a thunderstorm in which 0·44 in. of rain fell in 9 minutes.[1] Mr. Christie has since informed me that it occurred at 7.45 p.m., with great suddenness and violence, with a strong wind and rain, but no hail, and seemed to come from the direction of Ditcham. From Mrs. Barrow at Rogate and Mr. Watts at Slade I have learnt that the worst of the storm was at 7.45 p.m., that it came from the south-south-west, *i.e.* from the Ditcham direction, swept through West Harting and west of Up Park, wrecking some of the hop gardens, split oak trees, and the hailstones killed chickens. The centre, which was about a quarter of a mile wide, went right through Slade, accompanied by a roaring noise, and passed towards the north-west.

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[1] *Symons's Meteorological Magazine*, August 1906.

I am inclined to doubt its going to the north-west, as at Borden Wood, 3 miles north-east of Slade, a thunderstorm was reported between 7.30 and 8 p.m., when in about 15 minutes there was a rainfall of 0·47 in. mingled with a little hail; for a few minutes the wind was terrific, having a whirling motion, direction South-west. I do not think that branch of the storm advanced farther northwards, as Mr. Falwasser and Mr. Gamble, who live about 1½ miles west-north-west from Liss, report heavy rain on the north-west side of the hills, but not on the south-east side; Mr. Falwasser reports strong wind from South-west, with 0·48 in. of rain, from 8.20 to 8.40 p.m. At West Liss, only a mile west of the station, scarcely any rain was reported.

It would seem as if the southern storm had ended, and another had begun north of Liss some 20 minutes later; and here the experience of the guard of the Up train, which left Portsmouth at 7.15 p.m., is valuable, as guards are bound to keep an exact note of the time: "Arrived Liss 8.13, lightning then very sharp, very dark overhead.[1] Arrived Liphook 8.25, when it rained very heavily. The rain ceased before reaching Haslemere at 8.35, but about half a minute later the storm suddenly came on and there was a deluge for about 10 minutes. Arrived Witley 8.50, still raining but not so heavily. Arrived Godalming 9.2, when the rain had quite ceased."

At Fowley, near Liphook, Mr. E. A. Lee reported a storm from 8.15 to 8.45 p.m., with 0·51 in. of rain, with thunder and a wind which might be called a hurricane. At Conford, 1¼ mile north of Fowley, the storm was felt severely. At Downlands, a mile farther north, there was a tremendous deluge of rain between 8.0 and 8.30 p.m. Here apparently we have the beginnings of the storm which burst at Grayshott, nearly 2 miles farther north-west, and higher up on Hindhead. That there was no violent disturbance west of that narrow belt from Liphook to Grayshott was proved by Mrs. Lyndon the following morning, when she cycled from Grayshott, *viâ* Headley and Kingsley, to Alton, and looked out the whole way for signs of damage by the storm. At Alton she was at a meeting of the Guardians of the Alton Union, including the parishes of Grayshott, Bentley, Larham, Medstead, and Selborne, and asked several of them of the storm in their parishes. Everywhere, in the district named, there seemed to have been a heavy shower with lightning, but nowhere was any damage done, although several had watched with interest the storm in the Grayshott direction.

The road surveyor for the same district also reported no damage, except on the eastern edge of the Grayshott parish; and he would certainly hear of any serious damage. At Grayshott Hall, about 1 mile west of "Windwhistle House," the storm was not thought to be remarkable. At Alton, it was reported that the storm came from Winchester and went towards Guildford; it was worst at 8 p.m., at which time rain fell, with a very strong wind. At Ashdell, near Alton, there was very little rain, but a high wind and black stormy clouds from the west.

GRAYSHOTT.—We now come to the violent storm itself, and

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[1] This was probably the bank of cloud seen by Mr. Latter from Charterhouse, distant 17 miles.

"Windwhistle House" seems to have felt the first brunt of it. Mrs. Lyndon writes: "During the afternoon there had been some heavy storm clouds, but bright sunshine continued till about 6.15 p.m. Then some very fine dark clouds were noted with a lurid yellow light. At 8 p.m. the thunderstorm began with brilliant sheet-lightning, also what is popularly called forked- and chain-lightning; at no time was the thunder *very* loud, but the lightning was brilliant throughout. The storm seemed to 'gather' in the south, from the south-west, and then round to the east. Rain began at 8.20, by 8.40, 1·17 in. had fallen, but nearly the whole of this must have been in 15 minutes, say, from 8.23 to 8.38; no rain fell after 8.40. As the heavy rain fell the aneroid barometer rose as shown on barograph;—a young observer was kindly watching this for me. The barograph shows the jump at 8.23 (Fig. 1). The actual squall was of *very* brief duration; the wind was tremendous, quite hurricane force. Hailstones were reported, but I did not see any myself.

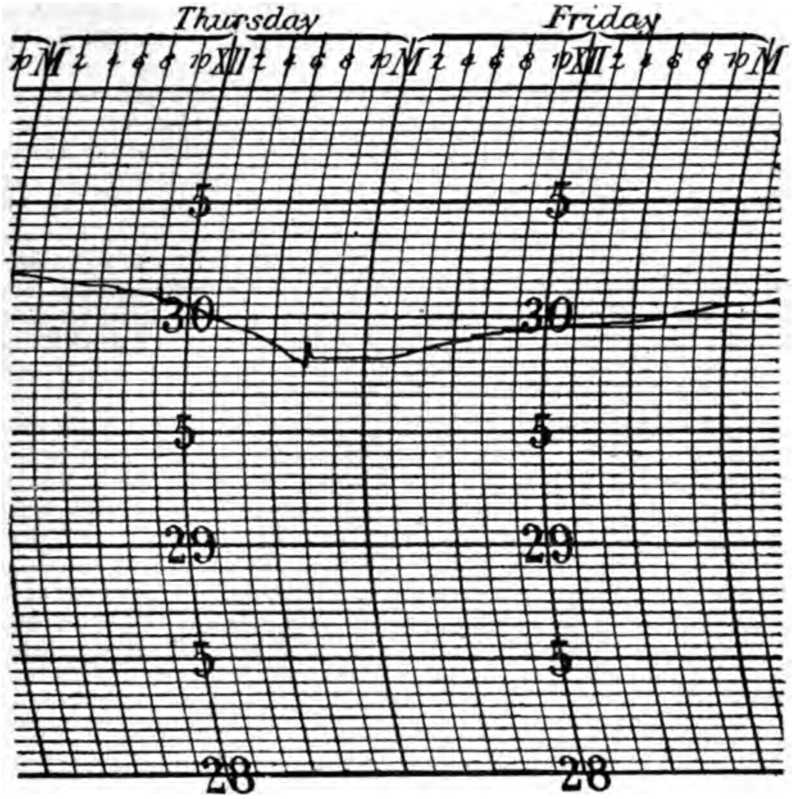

FIG. 1.—Barograph Record at Grayshott, August 2 and 3, 1906 (clock a few minutes slow).

"Walking along the roads later in the evening, I should suppose Windwhistle House was in about the line of the heaviest rainfall; after about 300 yards to the west-north-west the road was distinctly less 'washed'; some yards along the road to the south-east the rain must have been *very* heavy; but it lessened considerably before reaching Haslemere."

Hazelhurst is about 3¾ miles east-south-east of Grayshott; Grayshott is 660 feet above the sea, and Hazelhurst 550 feet; the highest part of Hindhead, 840 to 895 feet, is north of a line between the two places. I visited the Post Office near the "Royal Huts Hotel," and learnt that the storm of wind and rain had passed over it, but got no precise information.

Mr. Newman, at Hazelhurst, writes:[1] "The thunderstorm was remarkable for the rate of rainfall. From 6.30 p.m. beautiful cumulus clouds were passing over from the south-west; in the north a most curious fine net-like cloud of graceful form remained some time. At 8 p.m. lightning began in the south-west, and continued constantly, without intermission, for about an hour. Low growling thunder began about 8.15, and increased in volume, but was never very loud. At 8.30 rain suddenly fell in torrents, flooding the lawn in a moment; at 8.38 it ceased quite suddenly—amount measured for the 8 minutes' fall was 0·66 in. The thunder ceased after the rain, but the lightning continued, now in the north-east, where it came downwards to the earth in lines, occasionally in ordinary flashes. The storm travelled from south-west to north-east, by way of south and east. Wind remained South-west, and was of gale force for a few minutes about 8.25. Hail is reported one mile to the south-east, but none fell at Hazelhurst."

Miss Buckton, at Weycombe, about a third of a mile from Hazelhurst, gives an account similar to that of Mr. Newman, but her times are much earlier, and the sudden torrents of rain turned to hail; the rainfall registered was 0·75 in. in less than half-an-hour, and the hailstones were as big as peas, and came down with such force that the apples on the trees were marked and dented. Mr. Penfold, near Haslemere station, registered 0·46 in. of rain. Mr. Chambers, at Grayswood Hill, noted that at the height of the storm the eastern edge was nearly overhead; and as the storm passed on, the curious phenomenon was seen of the overhead storm bounded by blue sky, in which the moon was shining, and below again, on the eastern horizon, the electric discharge of the Horsham storm. At the crisis of the disturbance there was a sharp hailstorm, which riddled the leaves of a Japanese vine, and struck very heavily some of the fruit, but no glass was broken; a very violent but narrow current of wind took off the head of a large Canadian poplar, and split a Japanese ash in two. At Jesses, Mr. Parbury registered 0·59 in. of rain in a sharp thunderstorm with large hailstones.

We can note here the great differences in rainfall at places quite near each other, the rain giving way to hail on the eastern edge of the storm, and the narrow streaks of violent wind which were features of the storm everywhere.

GODALMING AREA.—Continuing to the north-east, the violent part of the storm passed between Sandhills and Lea Park; and at Mare Hill, 3½ miles from Hindhead, in addition to the uprooting of a large number of trees in various quarters, a house was demolished by a large elm which stood only a few yards distant. The cottage was practically covered by the tree, and the roof was crushed in by the great weight, and other damage done. A most remarkable incident occurred in Lemon Lane, at the north-east corner of Lea Park: a sheet of corrugated iron, measuring 6 feet by 3 feet, was torn off the Institute roof and carried some 50 yards, where it struck a tree. The speed at which it travelled can be imagined by the fact that a corner of the iron pierced the tree, and remained in that position without any support.

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[1] *Symons's Meteorological Magazine*, August 1906.

The limits of the violent storm here are shown by the fact that Witley on the east, and Elstead and Churt on the west, suffered very little. Mr. Watson, at Churt vicarage, remembers only threatenings of a very heavy storm all round Churt, but it passed off, apparently towards Guildford, in about an hour; he had heavy rain for about an hour.

Milford is about 1½ mile north-west of Lea Park. Mr. Young, of the nursery gardens there, has furnished me with the following account: "The storm first appeared in the west-south-west, and gradually approached until two distinct storms were raging—one in the west, the other in the south; and for a short time it looked as if the west storm would pass round the hills Farnham way, and the south storm round the hills Dunsfold way; but with remarkable suddenness the two storms seemed to meet, the lightning being most brilliant and incessant.

"A few drops of rain began to fall, with a peculiar rustle in the trees. Almost immediately the storm burst in all its fury; the hailstones which came down the chimneys in many cases were as large as blackbirds' eggs, and not unlike in shape. Windows were smashed, trees uprooted, and incalculable damage done. A peculiarity of the storm was the whirlwind, which twisted the tops out of the trees even in sheltered places, and hurled them back into the storm. The whole thing lasted about ten minutes only."

On my visiting Milford, the stationmaster informed me that the storm was first seen in the Witley direction; it began at 8.10 p.m. with a whirl of dust, and then rain and hail, and ended about 8.30. The wind was from South-west-by-west, with tornado force. The plants in his garden were peppered by hailstones.

Going towards Milford from the station, the first bad injuries to trees were seen about 500 yards from the station; the western limit of injuries was in Peper Harow Park, which gives a width of less than two miles for the violent belt.

At Mousehill manor-house the gardener said that it was quite still before 8 p.m., but there was lightning. At 8.30 the blow came without warning; rain and hail, with a sudden blast of wind. Many branches were broken, as from south-west to west, and some trees down. The hail did much damage to window panes in Milford and Mousehill.

A most interesting account of the storm is given in the *Carthusian* by Mr. O. H. Latter:—

"On the afternoon of the 2nd the wind was from South-east; but by the early evening (about 6 p.m.) a great bank of cloud had appeared over Hindhead and came drifting slowly towards us from the south-west, travelling almost at right angles to the main wind, and giving sure warning of a coming thunderstorm. The barometer had been dropping steadily all day—from 29·90 ins. at 8 a.m. to 29·63 ins. at 8 p.m. It was not until after 8 p.m. that it was evident that we were in for 'something big.' Shortly after 8 p.m. there began a most magnificent display of lightning; the flashes appeared to pass between two great masses of cloud that were lying one above the other, and were almost incessant in frequency.

"At about 8.35 a few splotches of rain, a roar of the whirlwind, and then such hail and rain as I had never witnessed before, and trust may never again; the noise was deafening, as though hundreds of loads of gravel were being shot from on high against the window panes, while all the while the thunder bellowed and crashed overhead. My front door was open when the tornado burst, and I had great difficulty in shutting it; but even in those few moments my hall was flooded, curtains, mats, and rugs blown upstairs, and a bucketful of hailstones, as large as sparrow's eggs, deposited at the foot of the stairs.

"In about eight minutes it was all over: the sky resumed its tranquil aspect as though nothing had happened, and the storm rolled quickly away to the north-east. The barograph in the library showed at the onset of the storm, at 8.35, a jump of $\frac{1}{8}$ of an inch, and immediately a fall of $\frac{3}{20}$, then gave a slight 'kick' and a steady rise. The rainfall during the eight minutes was 0·77 in., though there was probably rather more, as hailstones often jump out of the funnel of the rain gauge.

"The region of maximum violence in our neighbourhood was undoubtedly from Hurtmore Bottom to Guildford. The breadth of the disturbance was about 2 miles; its north-west boundary lay between Prior's Field and Puttenham, probably nearer the former, for Shackleford escaped serious damage."

Northbrook lies half-a-mile west-north-west from Charterhouse. The following account by Mrs. Ewart is taken from *Symons's Meteorological Magazine*. "The three minutes' tornado was quite terrific, coming over from Hindhead and carrying all before it. The lightning came hot and forked, and ran along the paths, no rain with it at first; suddenly the hail came—enormous square pieces—then the wind and rain. We rushed to shut the front door, and it took all the strength of three of us to do it, but not before the hall was strewn with hail. In my bedroom, the bed (16 feet from the window) was covered with hail and the floor white, as both windows were open when the hurricane struck us. Everything was soaked, and the carpet later on was like a pond. The wind made so much noise that we never knew until the hurricane passed over us that all the trees, except three, were blown down or stripped of boughs and leaves. All the fine old elms that looked like an avenue down the field are gone, and the dear old oak has its boughs torn off, and snapped on the right side where the gale struck it. Hardly a tree on this high open ground has escaped, and the wrecked look is too sad for words."

At Tilthams, a mile north of Godalming, Colonel Big-Wither writes: "The storm passed just north of this house, crossing Loseley, Braboeuf, and Guildford, so that we escaped damage. The rain recorded in my gauge was 0·63 in. The damage to trees in and about Guildford was prodigious."

About a mile north of Tilthams I saw some large elms, which had been uprooted, being carted away; several trees appear to have been blown down about there. At Broadwater, Llanaway, and Unstead the same tale of despoiled trees was told. At Compton and Loseley Park the wind played frightful havoc among the trees; Avenue Lodge, Compton, one of the lodges in Loseley Park, was wrecked by a huge elm tree. In the lane leading from St. Catherine's to Littleton no less than forty fine trees were down.

St. Catherine's suffered as severely as any of the outskirts of Guildford. The grounds of the houses abutting on each side of the Portsmouth Road were thick with timber, and at intervals all along the road, from Wycliffe Buildings to Peasmarsh, trees and branches lay strewn about the highway. In the Shalford Road district, also, the full force of the gale was felt, and a great number of trees were thrown across the road, making it quite impassable. A big fir tree fell on the cottages opposite the old toll house, and literally rent them in twain.

On the Farnham Road, on the slope of Hog's Back up from Guildford there was much damage done. At St. John's, Farnham Road, a large chimney stalk fell on the roof, which it pierced, and remained embedded. St. John's stands well off the road, and a magnificent spectacle was witnessed from its vicinity during the height of the tempest. The lightning played about the house incessantly, and about 9 p.m. a tremendous peal of thunder was followed by the collapse of the telegraph poles near at hand, which were precipitated into the garden. Six poles and thirty-two telegraph wires were blown down on the Hog's Back, in about a quarter of a mile.

GUILDFORD.—The day was one of the hottest this summer; there was not a breath of wind to temper the scorching rays of the sun, and the heat was oppressive throughout the day. Towards evening, however, a change set in, and by 8 p.m. heavy clouds had gathered overhead, and a storm appeared imminent. Slight peals of thunder, which were accompanied by occasional flashes of lightning, were heard about a quarter of an hour later. Within the next few moments, the thunder became louder, the flashes of lightning became vivid and continuous, and shortly after 8.30 p.m. the heavens opened. The wind suddenly sprang up, and a blinding storm of hailstones almost as big as marbles was driven with relentless force by a hurricane. Hail gave place to torrential rain, the fury of the wind, if anything, increasing.

The streets were deluged, North Street, in particular, represented a small river, and the low-lying parts of the town, especially Friars Street, were flooded to the extent of several feet. Some ten minutes before 9 p.m. the rain suddenly ceased, the disturbance overhead was less distinct, and the lightning, by which, during the storm, the town was continually illuminated, grew faint. By about 10 p.m. calm was restored, and the moon shone brightly in a clear sky.

The full force of the hurricane could only be realised by a sight of the destruction wrought. Scores of sturdy elms (in Woodbridge Park alone thirty-three trees were uprooted and broken off), many, several yards in circumference, were torn out of the earth by the roots and tossed like shuttlecocks; in many instances platforms of earth several feet deep adhered to the roots and were raised aloft. Considerable damage was also done to masonry both by the wind and falling trees.

Two fatal accidents occurred in Woodbridge Avenue: a row of large elm trees skirted either side by the road, and it would appear that two youths and a young woman were passing through the avenue at the time of the hurricane. Suddenly, and without the slightest warning, six of the trees yielded to the force of the wind and came crashing down into the roadway, literally obstructing the passage for some 50 yards. Beyond, and opposite the terrace of cottages, lay some other trees which had fallen practically at the same time. Cries were heard issuing from the mass of wood and foliage in the roadway, and a number of willing helpers were on the spot in a moment or two. Great difficulty was encountered in the search for the injured; for, in addition to the darkness, the road was flooded to the extent of about 2 feet of water—the men who were searching beneath trunks of the trees and amid foliage were standing knee deep. The victims, when rescued, were unconscious, and two of them succumbed.

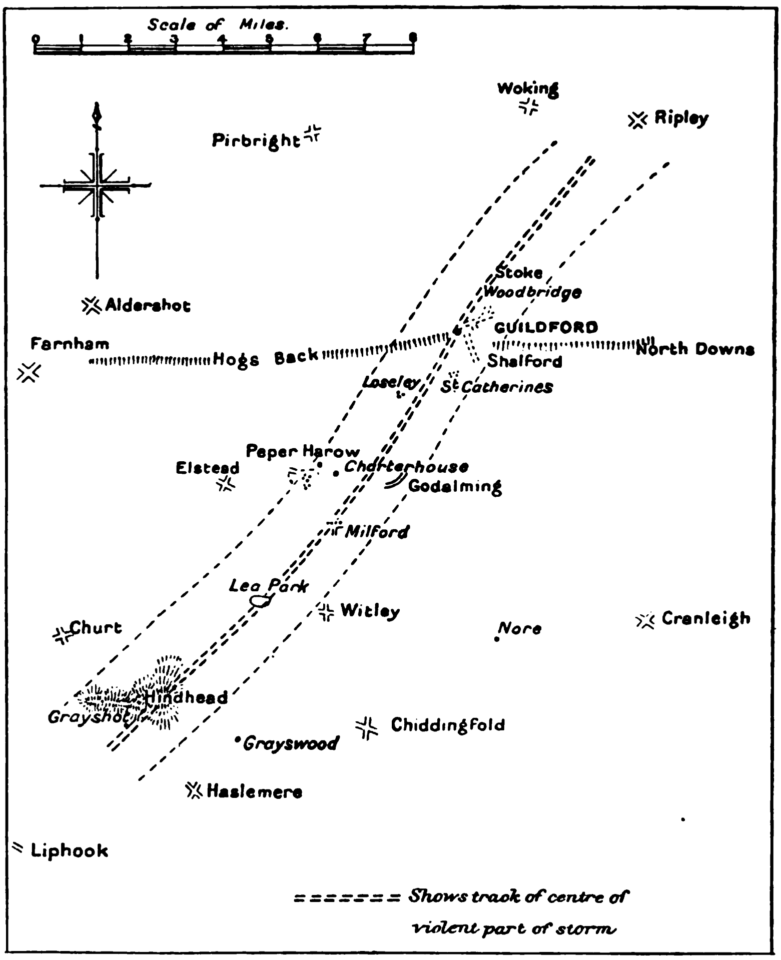

FIG. 2.—Map showing Track of Storm.

At the railway station a chimney-stack over the booking hall was dislodged, and half a ton or more of bricks and mortar came crashing through the storeroom floor into the hall. The stationmaster, Mr. Sumpster, has informed me that, after a careful estimate of the time, it has been registered that the chimney fell at 8.40 p.m.; this determination of exact time is the only accurate one I have been able to get for Guildford, and it is very valuable in gauging the rate of progress of the storm from Charterhouse. Some of the seats on the platform were blown on to the permanent way, and some trucks were blown off the rails in the goods yard. The line between the two tunnels at the south end of the station was blocked by fallen trees, and traffic generally was somewhat delayed.

In Shalford Road the storm wrought sad havoc among the stately elms which border the road. The scene on the following morning, before the wreckage had been removed, was a remarkable one. Everywhere, practically, the roadway was carpeted with branches, large and small, in full foliage; while on the east side of the road a new hedge was constituted by the upturned roots of trees which had been blown down into the cornfield.

Hailstones, as clear as crystals, fell during the storm of the size of large marbles.

The *Surrey Advertiser* and *Surrey Times*, from which I have extracted the details of the Guildford part of the storm, give many more accounts of damage done in many places, which need not be repeated here, as enough has been said to show the destructive violence with which the storm burst—especially in the northern part of the town about Stoke Park, where scores of trees in the soft ground by the river side were uprooted.

The farthest point to which I have traced damage was at Ripley, 4 miles from Guildford, and at Ockham, where a terrific hailstorm at 8.30 p.m. wrecked a garden, and a cottage was damaged. Farther north and east it is impossible to distinguish the Guildford storm from the Horsham storm and the Western storm. Captain Carpenter, at Sanderstead, observed, at 7.45 p.m., two magnificent displays of lightning working up, one from south-south-west, the Horsham storm, and the other from south-west, the Guildford storm. The guard of the up-train leaving Guildford at 8.34 ran through the storm, and found very heavy rain between Woking and Walton, from 8.43 to 8.55, and had the wind on the near or north side of the train, this was the West storm. Between the South-west and the South storms there seems to have been an area of very moderate rainfall.

LIGHTNING.—All the observers record the peculiar and magnificent display of the lightning. I observed it myself from Chiddingfold, on the south-east edge of the storm. The lightning was incessant and darting from cloud to cloud, as if netted; one realised that one was looking at the under surface of a great storm, the origin of which was high above. I only saw red flashes, like the discharges in hot moist air, and in no case that I know of was there a discharge from cloud to earth. Some observers, however, have reported flashes from cloud to earth; but I think myself that was due to perspective, the discharges being seen end on.

CONCLUSION.—In seeking a cause for the violence of the Guildford storm, one turns naturally to the Weather Chart of 6 p.m., at which time the cloud banks were observed gathering in the south-west from Hindhead and Godalming. The isobars show a low and falling barometer to the north-west, with a slightly rising barometer over France to the south-east; and a normal to the curves passes about Guildford; a thunderstorm had already commenced at Salisbury and at Weymouth. The day is described as very hot and close at Guildford, but it was not so at Chiddingfold nor at Cranleigh. I should imagine that after 6 p.m. the gradients rapidly became very steep in a line lying south-west and north-

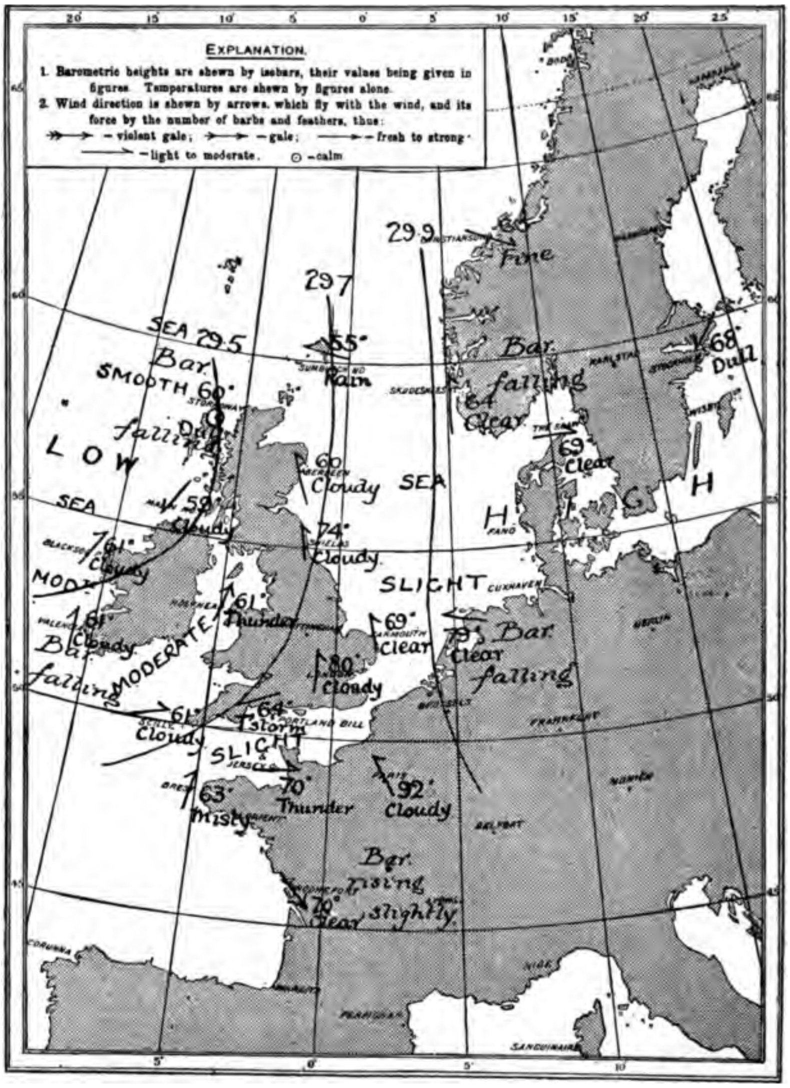
EXPLANATION.
1. Barometric heights are shewn by isobars, their values being given in figures. Temperatures are shewn by figures alone.
2. Wind direction is shewn by arrows, which fly with the wind, and its force by the number of barbs and feathers, thus:
- violent gale; - gale; - fresh to strong;
- light to moderate. ⊙ - calm
29.9
Fine
29.7
SEA 29.5
Bar.
SMOOTH 60°
falling
LOW
55°
Rain
Bar.
falling
64
Clear
68°
Dull
69
Clear
60
Cloudy
SEA
H
H
SEA
59°
Cloudy
61°
Cloudy
MOD
74°
Cloudy
SLIGHT
61°
Thunder
61°
Cloudy
Bar.
falling
MODERATE
69°
Clear
80°
Cloudy
Bar.
Clear
falling
61
Cloudy
64°
T.storm
SLIGHT
70°
Thunder
63°
Misty
92°
Cloudy
Bar.
rising
slightly
70°
Clear

Fig. 3.—Weather Chart, 6 p.m., August 2, 1906.

east and passing over Guildford, the result being a line squall, especially violent at that point.

I would call attention to a remarkable upward jump of about from $\frac{1}{10}$th to $\frac{1}{5}$th of an inch, followed immediately by a fall of lesser extent, and then a continued rise, recorded on every barograph I have seen in the storm area from Hindhead to London. If it were possible to get the exact time error of each barograph, and hence the exact time of the jump, it would perhaps give valuable information as to what was going on overhead. Careful measurements, with estimation of the time errors of the barographs at the following places, show the jump at Grayshott, 8.23; at Charterhouse, 8.35; at Guildford, on three different barographs, 8.34, 8.40,[1] and 8.52; at Burgh Heath, 9.10, very slight but perceptible; and at Thames Ditton, 9.28.

Space does not allow me to include all the valuable and interesting remarks which observers have kindly sent me, nor the valuable notes on the progress of the storms as seen from Nore by Colonel Godwin-Austen, and which are to be found in *Symons's Meteorological Magazine* for August. My thanks are due to the many correspondents who have kindly assisted me in this investigation.

DISCUSSION.

Prof. A. S. **Herschel** wished to ask Admiral Maclear whether the Stoke Park referred to as an illustration of the violence of the wind, was Stoke Park near Slough, as he would not have supposed that anything so tempestuous as to overthrow a large elm occurred near Slough. (Mr. **Marriott**—This Stoke Park is in Surrey, in the immediate vicinity of Guildford.) He, Prof. Herschel, said that between 8.30 and 9.30 p.m. a storm of very brilliant lightning passed over Slough of an entirely different character from the hurricane tempest described by Admiral Maclear. His impression was that at about the middle of that time a storm of lofty lightning (timed by weak thunder of the flashes overhead to have been about 5 miles high), accompanied by gusty West wind and by only late and gentle rain, must have been passing down the Thames Valley quite independently of this desperately destructive Guildford one.

Dr. C. **Theodore Williams** said that, as regards his garden, the damage had been chiefly due to the hail and not to the wind. He had had a good crop of "keeping" apples which were spoiled by the hail, nearly all of them showing three or four brown marks indicating the bruises caused by the hail. These apples had to be cooked early as they would not keep. There was no wind. At Lea Park, about one and a half miles off, great devastation had occurred from the hurricane. The trees had been rooted up, especially the elms. Witley Common contains a large number of fine firs, and these were not rooted up, but half the tops were twisted round or broken off, and the paths on the Common blocked by the débris. There seemed to be different areas attacked by the wind and the hail.

Mr. F. C. **Bayard** said that he presumed the storm had gone along the top of the ridge, passing below Newlands Corner and St. Martha's, and had crossed the river, coming to St. Catherine's at the top just by Guildford. He would like to know whether there was any information available from Newlands Corner and St. Martha's, which were two very high wooded points.

Mr. W. H. **Dines** remarked that he had been away from home and had not seen anything of the damage done to the trees. The storm seemed to have taken a track a little north of the railway from Guildford to Surbiton, ending in the neighbourhood of Oxshott. Several houses to the north had had their windows broken by the hail. His anemometer only registered 53 miles, but some damage occurred to a house that was being built close by, and one pane of glass was broken by the hail in his garden.

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[1] Probably the correct time, as the chimney at the station fell at 8.40.

Mr. W. **Marriott** said that on the evening of August 2 every one in London had an opportunity of watching a brilliant display of lightning. It was reported in the papers that there were over 600 flashes in 52 minutes. He showed two lantern slides of lightning taken by Mr. M. Robertson. In connection with newspaper reports, he remarked that one of the illustrated papers had published a reproduction of a photograph of lightning entitled "Nature repeating Itself." He had applied to the manager for a copy of this photograph, but was informed that after they had published it, they "made inquiries from the photographer, and he is now inclined to think that it is not a photograph of a lightning flash at all, but some lights in the street which came across the lens while the plate was exposed waiting for the flash." Mr. Marriott referred to the remarkable hailstorm which occurred on the same evening in the neighbourhood of Bedfordshire, Huntingdonshire, and Cambridgeshire, where considerable damage was done (see p. 60). In a Bedfordshire paper there had been an illustration from a photograph showing an agricultural motor working two binders with a lightning flash passing between the motor and the camera. He had asked for a copy of this photograph, but only received some time later an illustrated catalogue of agricultural motors, etc., with an exactly similar photograph minus the lightning flash. It appeared therefore that we could not always accept the photographs appearing in the papers as genuine records of meteorological phenomena. One interesting feature was the great jump in the barometer. This was a usual occurrence in thunderstorms, and was probably due chiefly to the compression of the air by the heavy rain. Mr. Symons's Brontometer had recently come into his hands, and so he was able to get a record from it during the storm of August 2, which he exhibited to the meeting. The lightning was extremely frequent, though one could hardly hear the thunder. He had subsequently tried the Brontometer in windy weather, and when there was a gust of wind the barometer rose, indicating that there was compression of the air. He had often looked at an aneroid during a railway journey; when going through a tunnel there was a slight decrease of pressure, but immediately on emerging from the tunnel the hand went up ·02 or ·03 in., owing to the increase of pressure. He thought that the sudden jump in the barogram at Grayshott was largely due to the rainfall of 1·17 in. in 15 minutes.

Mr. T. P. **Newman** remarked that at Hazelhurst the thunderstorm had continued for some time before rain fell. At 8.25 p.m. there came a sudden gust, a "slam" of wind up the valley blowing all before it; it was in no sense a whirlwind. It lasted only two or three minutes and did no damage. At 8.30 rain suddenly began to fall in sheets, and in a moment the lawn was flooded; at 8.38 p.m. it ceased as suddenly as it had begun. The quantity in the gauge was 0·66 in. Mr. Latter's record at Godalming, farther on in the track of the storm, was 0·77 in. during eight minutes; at Guildford there was more rain, but the rate was not so great. Hazelhurst is in a somewhat narrow valley running N. and S., and he, Mr. Newman, was looking E. and doubtless watching the Horsham storm, but his view was impeded by the opposite hill. The lightning discharges were *constant* and principally from cloud to earth, after the rain nearly all were cloud to earth. At Loseley Park near Guildford it was stated that more than a thousand trees had been blown down, which was probably correct.

Mr. W. B. **Tripp** remarked that the sky presented a most thundery appearance in the N.E. and S.E. and subsequently a heavy thunder came from that part. In the West there was a most extraordinary sky, with heavy clouds and brilliant sun-pillars with most singular shadows on the clouds to the north of and above the sun's position. These shadows were like the shadows of church steeples, the pointed portion upwards. He could not account for them. This was about 7 o'clock.

Mr. R. G. K. **Lempfert** said that Admiral Maclear had in his paper expressed a wish that he would discuss the general conditions over the country as a whole. He (Mr. Lempfert) had been collecting information for the date in question. The storm had occurred at night and there had been much sheet lightning both before and after its passage at many stations. This was rather unfortunate, as many observers had noted in the registers merely the time of first and last lightning. Unless the accounts were very detailed it was not possible to identify corresponding phases in a storm of lengthy duration. Entries such as "Thunderstorm 8 p.m. to midnight" afforded but little assistance in tracing out the details of a complex phenomenon across the country. Traces from self-recording instruments, provided that the time-scales could be evaluated with sufficient accuracy, gave more precise information. From the curves which he had had an opportunity of examining, it appeared probable that an atmospheric disturbance—using the word in a strictly non-technical sense—had occurred over a very wide area. He would like to ask Admiral Maclear whether the trees which had been blown over in the Guildford district all lay in the same direction, and if so, what was the direction of the very strong wind which did so much damage.

Captain A. **Carpenter** observed that a feature of the storm commonly noticed at Croydon was the appearance of the bright moon on a cloudless sky between the apparent centres of disturbance, which shewed that there were no upper clouds. From South Croydon there appeared to be three centres—one, an ominous black cloud first came up from South-south-west, travelling in a N.E. direction probably over Westerham, but we got no rain from it; another, giving a magnificent display of lightning, came up from direction of Dorking and passed over Croydon with thunder crashes and hail. Half an inch of rain fell in about half an hour. The third was visible in the direction of Guildford, the lightning being very vivid. It would be very difficult to tell the true direction of a storm or cloud not travelling directly towards ourselves, but in this case the central disturbance came up from S.W. and passed right over us.

Prof. A. S. **Herschel** wished to refer to a communication he had lately received regarding a thunderbolt which was asserted to have fallen on the afternoon of the 2nd or 3rd of August last in the western part of Northumberland. A Member, at Mirfield in Yorkshire, of the North of England Mining Institute, Mr. John Nevin, who rented a moor for shooting near Haltwhistle-on-Tyne, from its owner in the same neighbourhood, Mr. J. B. Lowes, was shown by the latter, on the 16th of August last, a large hole 4 or 5 feet in diameter which had been struck in the ground on a flat part of the moor, and was then full, after a week's continuous rain, to within a foot of the top, with peaty water. Supposing that a large aerolite had fallen there, he offered a reward for its excavation; but in order not to disturb the grouse, this was postponed for a time. On October 29, Mr. Nevin made a special visit of examination to the place, accompanied by the gamekeeper, Mr. Robert Hall, and by the farmer, Mr. James Turnbull, who first saw the hole, on Sunday, August 5, while looking after sheep, and who had then supposed that the thunderbolt fell during a thunderstorm on the afternoon of Thursday or Friday the 2nd or 3rd of August, but on which of those two days he could not say quite surely. Since Mr. Nevin's first visit, Mr. Hall had dug out the hole to a depth of 12 feet, without meeting with a solid body, no deeper sinking being practicable without careful timbering of the pit's sides to keep out peat and water; but a hole 3 inches in diameter and as deep as a walking-stick could sound it, without reaching any bottom, continued there somewhat obliquely downwards still, inclined towards south-west. Later, towards the middle of November, water had again nearly filled the hole, and this, joined to the inclemency of the weather, put a final stop to the research.

Mr. Nevin made, and communicated to the Mining Institute, with a report of this examination, a carefully measured plan of the hole's surroundings. Furrows, seeming to have been dug by a plough of 5-12 yards radiated out from the edge of the large hole in a number of directions, at the ends of some of which holes about 4 inches in diameter sloped obliquely down towards the centre hole, either tapering to nothing, or, like similar slanting holes found in the sides of the pit while digging it, had no termination that could be sounded with a 3-foot walking-stick. Fragments of the turf covering of the hole, 1 foot to 1 yard wide and 1 to 1½ feet thick, were tossed to various distances of 8 or 10 to over 25 yards (the two largest pieces), in various directions from the cavity, well indicating the mighty store of energy collected in and called into operation by the lightning flash. But though he, Prof. Herschel, had suggested that the hole perhaps owed its origin to a hoaxing, or other disporting use of blasting-powder, Mr. Nevin had replied to this that while its appearance rather suggested a steam explosion caused by a very hot body falling at a high velocity into the wet peat, it was in no way similar to the effect of dynamite. He also said that Mr. James Walton, J.P., of Allendale, had told him of a recollection which he had of, when a boy, in 1860, while sheltering with his father on a moor about 6 miles west of the scene of this thunderstorm, having both of them observed a ball of fire, intensely bright, fall on the moor at some distance from them, which it was found next day had killed some sheep and had made a great hole in the ground. Mr. Nevin suggested that these occurrences probably take place more often on the moors than is generally supposed, or than they may happen to be well seen and noted.

Dr. W. N. **Shaw** was most interested in the attempt to unravel the physical causes giving rise to the barometric changes observed in the thunderstorm. Mr. Marriott had referred to the variations of reading on an aneroid in a railway tunnel; in the case under discussion one had to attempt an explanation of the phenomena observed without the assistance of a tunnel. One conclusion had been arrived at. It appeared that the phenomena were mostly of the nature of a line squall, that is to say, there was a wave-front of barometric disturbance travelling across the country. The line of front connected the points at which there were "centres of disturbance" simultaneously. If you were to move along the line you would find disturbance of some kind at all points, with maxima at some points and minima at others. Moving, however, with the line, the whole set of phenomena would travel across the country and display maximum and minimum intensity at different points in the line of front. Points of maximum intensity might be called travelling "centres"; Capt. Carpenter said they were so because he had seen them coming. The question was, how would these appearances be represented on a map. If Admiral Maclear could spare another evening, it would be desirable to enter into the physical questions more fully at a future meeting.

Admiral J. P. **Maclear**, replying to various queries, said that regarding Newlands Corner, the violent part of the storm did not reach so far east; Newlands Corner itself was included in a rather quiet area between the Guildford and Horsham storms. Loseley Park, had received a great deal of damage. About the trees blown down, these all fell in the same direction, pointing east or north-east, except one in Peper Harow Park, which lay south to north; if there is a longer root one side of a tree than the other, the tree will swerve to that side when it falls.

The President (Mr. Richard Bentley) remarked that the impinging of three storms upon Guildford at the same time was a most unusual feature, and that all interested in meteorology were under great obligation to Admiral Maclear for the large amount of information he had gathered together on the subject, and so succinctly presented. It was to be hoped that the publication of the present paper might lead to some further investigation into the initial stages of the three storms and the causes of their convergence. With regard to the immense destruction of trees, it should be borne in mind that the storms followed a time of severe drought, and in consequence of this not only were the roots of trees parched and brittle but also the soil covering them and so "anchoring" these trees was very greatly diminished in weight.

Climate of the Wheat Area of Central Canada.

Prof. L. W. Lyde, in a paper at the recent meeting of the British Association at York, discussed the "Climate of the Wheat Area of Central Canada," in which he gave the following summary of the climatic conditions prevailing at the different seasons:—

In this area there is a typically continental climate modified by latitude and lakes: a long summer day, slow rotation of earth, chinook winds. The operation of these factors is seen in the character of the forest.

Spring is sudden and short, being limited, as far as the wheat cultivation is concerned, to the four weeks in *April*, when there is an average daily maximum of (+ and −) 50°; the east being 5° colder than the west, where snow is not "packed," and is therefore easily licked up by the chinooks.

With unit of population, *i.e.* one family of five persons (at least two of them males), the maximum of plough, harrow, and drill that can be "risked" is 80 *acres in the four weeks.*

Summer is the rainy season, beginning with mid-May rains and ceasing with mid-August dry spell. Temperature rises steadily May-June, with rain; Winnipeg district has more than half, Qu'Appelle and Prince Albert districts have more than three-quarters of the total rainfall in the three "growing" months (May, June, July). Mean temperature (June-August) on Brandon-Battleford curve is 62°·5, which is equal to that of the best English wheat land. The duration of sunlight varies from about 15½ hours per day at midsummer in Winnipeg district (averaging one hour per day more than Chicago district from June 15 to July 1) to over 17 hours at Prince Albert, with very high percentage of bright sunshine (result, a fine-coloured grain), especially along Brandon-Battleford curve.

Duration of night. There is a short night, *i.e.* a short time for radiation, but a comparatively long "cool" spell, which is as favourable to wheat as it is unfavourable to maize (and mosquitoes).

Autumn is a dry season: (*a*) August, harvest. One family can bind and stock 70-80 acres in one week (if there is a third male, one family can cart this in a second week to central stack, and have the equivalent of 1200 bushels of grain ready for thresher by the end of August); (*b*) September, average temperature drops 10°, and loses 70 hours of bright sun: October drops 10° more. Therefore it is desirable to plough at once. Loss of "fall" plough means loss of early seeding the following year—that is, loss of yield per acre, loss of weight per bushel, loss of market by water transport.

Winter.—Length and intensity of cold do not affect the north limit of wheat in summer, but guarantee cleansing of ploughed land, and leave no excuse for grain not being also clean.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

November 21, 1906.

Ordinary Meeting.

RICHARD BENTLEY, F.S.A., President, in the Chair.

W. R. BALDWIN-WISEMAN, Assoc.M.Inst.C.E., Shirley Road, Southampton;
WALTER WILLIAM BRYANT, B.A., F.R.A.S., Royal Observatory, Greenwich;
Hon. FITZ-WALTER G. P. BUTLER, R.N., The Admiralty, Whitehall;
JAMES REUBEN GIBBS, 12 Rathin Road, Withington, Manchester;
HUBERT JOHN WILLIAM GIDLEY, Hong Kong;
J. WESSLAY HOFFMAN, D.Sc., Prairie View, Texas, U.S.A.;
ERIC WILFRID KITCHIN, Assoc.M.Inst.C.E., The Priory, Watford;
Mrs. MINNA LANE, Dangstein, Petersfield;
C. L. J. M. PARKINSON, M.A., Tuesday Market Place, King's Lynn;
H. J. BINGHAM POWELL, Assoc.M.Inst.C.E., Lima, Peru;
ALFRED STANLEY TUXFORD, Caine Road, Hong Kong; and
Hon. HUGH ARCHIBALD WYNDHAM, Kroondraei, Standerton, Transvaal,
were balloted for and elected Fellows of the Society.

The following communications were read:—

1. "THE INTERNATIONAL CONGRESS ON POLAR EXPLORATION AT BRUSSELS, SEPTEMBER 1906." By HUGH ROBERT MILL, D.Sc. (p. 1).

2. "THE ABNORMAL WEATHER OF THE PAST SUMMER AND SOME OF ITS EFFECTS." By WILLIAM MARRIOTT, F.R.Met.Soc. (p. 5).

December 19, 1906.

Ordinary Meeting.

RICHARD BENTLEY, F.S.A., President, in the Chair.

REGINALD MANSFIELD BALSTON, Mereworth, Maidstone;
Capt. KENELM E. DIGBY, Eadestown House, Worthing;
Major GEORGE RAMSAY ELLIOT, Parkhurst, Isle of Wight;
Major GERALD EDWARD GALBRAITH, Karachi, India;
Capt. ARTHUR ARCHIBALD GALLOWAY, Portsmouth;
Capt. C. G. E. J. MANNERS, Belgrave Mansions, Belgrave Square, S.W.;
Mrs. H. R. MILL, The Hollies, Mill Hill, N.W.;
ROBERT L. MOND, M.A., F.R.S.E., 20 Avenue Road, N.W.;
Major CECIL WYBURN PETERS, Sunbury Manor, Middlesex;
HUGH REID, M.Inst.C.E., Belmont, Springburn, Glasgow;
Capt. EDMOND JOHN WARRE SLADE, Fareham, Hants; and
WILLIAM WILSON, Beauchief Abbey, near Sheffield,
were balloted for and elected Fellows of the Society.

Mr. J. W. FORRESTER and Mr. T. P. NEWMAN were appointed Auditors of the Society's Accounts.

The following communication was read:—

"THE GUILDFORD STORM OF AUGUST 2, 1906." By Admiral J. P. MACLEAR, F.R.G.S. (p. 41).

CORRESPONDENCE AND NOTES.

Lectures on Meteorology.

During the past three months Mr. William Marriott has given Lectures on Meteorological subjects in connection with the Society's scheme for diffusing a knowledge of Meteorology at the following places:—

October 27.—Christ's Hospital, West Horsham.
November 14.—The College, Eastbourne.
November 24.—St. Felix School, Southwold.
November 28.—Christ's College, Brecon.
December 18.—Literary and Scientific Institution, Highgate.

A Meteorological Exhibit was shown (under the charge of Mr. W. J. Marriott) on November 8, at the Conversazione of the Sidcup Literary and Scientific Society.

Bureau Central Météorologique, Paris.

On December 31, 1906, Mons. E. Mascart retired from the post of Director of the Bureau Central Météorologique de France, and Mons. Alfred Angot has been appointed his successor.

Upsala Meteorological Observatory.

Dr. H. H. Hildebrandsson retired from the office of Director of the Meteorological Observatory, Upsala, Sweden, on December 31, 1906. Mons. F. Akerblom is *ad interim* discharging the duties of Director.

Netherlands Meteorological Institute.

Mons. E. van Everdingen has been appointed Director-in-Chief of the Royal Meteorological Institute of the Netherlands, De Bilt, Utrecht.

Meteorological Essay for the Howard Medal, 1906.

In order to encourage the study of Meteorology, the Council of the Royal Meteorological Society in 1899 decided to give annually the Howard Silver Medal for the best essay on some selected meteorological subject, by one of the cadets of the Thames Nautical Training College, H.M.S. *Worcester*.

The subject of the essay chosen for the year 1906 was "The Storm Areas of the Globe," and the Medal has been awarded to Cadet J. A. P. Blackburn. His essay is printed below as a specimen of the class of papers submitted for this award, and incidentally to show the amount of knowledge on the subject acquired by the candidates for the Medal. (The paper was accompanied by two diagrams, but these are not reproduced.)

THE STORM AREAS OF THE GLOBE.

By J. A. P. Blackburn.

Before proceeding to a discussion on the storm areas, it will not be out of place to briefly explain what wind is, and also the cause of it.

Wind is air in sensible motion.

Wind is primarily caused by the air in the equatorial regions becoming heated and rising, and the colder air from the polar regions flowing in to take its place.

The force of the wind accompanying such a difference of temperature does not depend on the mere height of the barometer at the ship, but on the difference between that height and that which subsists over the neighbouring seas. These differences of pressure are spoken of as barometric gradient, and the comparison for their difference which has been adopted is the difference of the heights expressed in ·01 in. for 15 miles of difference. The greater this difference the nearer the isobaric lines will be together on the chart, the stronger will be the winds accompanying that difference, and the steeper will be the gradient.

The sailor must be specially watchful for those great decreases of pressure which usually herald storms; but gales are sometimes caused by the sudden rise of pressure which often follows barometric depressions.

Sailors should never forget the simple but excellent rules known as Buys-Ballot's Laws. They are as follow:—

In the Northern Hemisphere stand with your face to the wind, and the pressure will be lower on your right hand than on your left.

The reverse holds good for the Southern Hemisphere.

As has already been stated, wind is primarily caused by differences of temperature, but the direction of the wind is governed by another very distinct influence which it is necessary to understand, as it fundamentally affects all classes of wind, but calls for special attention in the case of the most dangerous storms, namely gales and hurricanes.

When the air is apparently wholly at rest, and a complete calm prevails, the air is in reality moving at a considerable rate with the earth's surface.

At the Equator the earth's revolution is about 1000 miles per hour, and gradually decreases till at the Poles it is zero. While the air remains at rest, relative to the earth's surface, it is not perceptible, but it at once becomes effective when the air is impelled to a latitude having either a higher or lower rate of revolution.

For the above reason, air setting out from a place having a lower rate of revolution in the Northern Hemisphere, and arriving at a latitude having a higher rate of revolution from west to east, will be impressed with a motion from east to west. It will be thus seen that air travelling from a high northern latitude to the Equator will, by the motion of the earth, be impressed with a North-easterly motion. The reverse holds good for the Southern Hemisphere. Hence we have the North-east Trades in the Northern Hemisphere, and the South-east Trades in the Southern Hemisphere.

Of all the winds which the barometer warns us, the revolving storms of the tropical regions are the most important.

It might be stated here that the wind in blowing from the Equator polarwards takes a curved track. The circulation round the storm area is that round an area of low pressure, and is termed cyclonic.

In the Northern Hemisphere the point of curvature is in about lat. 30° N., and in the Southern Hemisphere the point of curvature of the storm track is in about lat. 25° S.

The right-hand semicircle is that one on the right of the storm as it advances; that on the left is the left-hand semicircle.

One semicircle is always known as the dangerous semicircle, for a ship in it would be liable to be driven across the track of the storm. Such would certainly be the case if the ship ran before the wind.

In the Northern Hemisphere the right-hand semicircle is the dangerous one, and in the Southern Hemisphere the left-hand semicircle is the dangerous one.

All revolving storms are known to the meteorologist as "cyclones," but they have different local names, thus: "tornadoes" off the West Coast of Africa; "hurricanes" in the West Indies and Pacific Oceans; "typhoons" in the China Seas.

These revolving storms are most frequent in the West Indies and in the South Indian Ocean, specially about Mauritius. These storms are most frequent in the Northern Hemisphere from July to November, and in the Southern Hemisphere from December to May, both months inclusive; but in the Bay of Bengal and Arabian Sea they are strongest about the time of the change from one monsoon to the other. The majority of these storms seem to travel on a line not due west, but inclined a point or two towards the pole of the hemisphere in which they were generated; they gradually curve round, and finally blow towards the north or north-east in the Northern Hemisphere, and the south or south-east in the Southern Hemisphere.

The storms of the North Atlantic chiefly curve round in the Gulf of Mexico, follow up the seaboard of North America, and often follow the Gulf Stream across the Atlantic to Europe, skirting the northern verge of our islands.

The storms of the Bay of Bengal appear to originate in the neighbourhood of the Andaman Islands, and those of the Arabian Sea about the Laccadives.

The storms of the former sometimes cross the Indian Peninsula, but the majority curve north-west or northward in Bengal, and then return to the eastward.

The typhoons of the China Seas commence from North-west to West, and finally curve round and blow to the north or north-east.

If an observer in the North Temperate Zone were to note a fresh wind from the South or South-east, an area of low pressure will be in existence to the south-west or south of him, granted that the temperature was high and the barometer falling steadily. If the vessel were to sail to the west or get into the safe semicircle for the Northern Hemisphere, the wind would blow from the West (which change usually accompanies a heavy rainstorm), the barometer will rise as suddenly as it fell, and the bad weather area will pass off to the east.

From this we get the rule: In the Northern Hemisphere gales usually commence at South or South-east and end at West or North-west; in the Southern Hemisphere, they usually commence at West or North-west and end at South-east or South.

The great characteristic of revolving storms is that, in the Northern Hemisphere, the winds revolve round the area of lowest pressure in a direction contrary to that of the hands of a watch, which helps an observer to distinguish between cyclones and gales, in which the direction of the wind varies little if at all.

This motion assists him in determining the approximate position of the centre or vortex of the storm. The vortex is that point where the fury of the wind is greatest, the wind changes most rapidly, and the sea is most turbulent. At the centre of these storms the barometer sometimes stands two inches lower than it would in the neighbouring areas.

In the Northern Hemisphere, between the latitudes of 30° and 40° N., and on the parallel of Cape Horn in the South Atlantic, there are areas of high pressure.

Along the Equator, and within a few degrees of it on either side, there is an area of very even barometric pressure, hence causing the calms of Cancer and Capricorn, or, as Maury calls them, the Doldrums.

[The writer, by means of a chart, gave some idea of the storm areas of the globe.]

Having given an outline of the storm areas, it may be as well to say a few words as to these storms.

As soon as an observer has reason to think that he is in a storm area, he should heave-to. There are two things that should be made certain of at once, and these are (*a*) the direction of the storm's track, and (*b*) the approximate bearing of the centre of the storm. As the only way to do this is to heave-to, no time should be wasted in so doing.

It is always the best plan to presume that the vessel is in the dangerous semicircle, so she should be hove-to on the starboard tack in the Northern Hemisphere, and on the port tack in the Southern Hemisphere.

At the commencement of a storm, twelve points on the right hand should be allowed in the Northern Hemisphere for a rough bearing of the vortex.

After the barometer has fallen 0·3 in., ten points should be allowed; and when the barometer has fallen 0·6 in., eight points should be allowed.

The usual signs that herald a storm are: (*a*) sudden fall of pressure, or even a cessation of its diurnal range; (*b*) usual foreboding appearance of weather; (*c*) sea usually running in a long, steady swell from the direction in which the storm is approaching; (*d*) wind comes in gusts.

Destructive Hailstorm in Bedfordshire, August 2, 1906.

[The following account of this storm has been extracted from the *Bedfordshire Times and Independent*, August 10, 1906.]

The thunderstorm which passed over the country on the night of Thursday, August 2, levied very heavy toll upon the crops in some of the parishes north of Bedford. The rain and electric disturbance were very general, but the terrible fall of hail was very partially distributed in this county following two main tracks: one from the borders of Huntingdonshire, and passing over Bolnhurst, Milton Ernest, Pavenham East, and Oakley, and another taking a line from Newport Pagnell through Astwood and Stagsden to Bromham. All accounts agree that it is no exaggeration to say that many of the hailstones were as large as walnuts and took the form of rough lumps of ice. They thickly covered the ground, and in some parts were not wholly melted until well into the following day, specimens indeed being brought into Bedford on Friday morning. The appended accounts from our correspondents give some idea of the havoc which has been wrought upon windows, greenhouses, and crops, but some of the incidents related seemed so incredible that our representative journeyed over a few miles of the country to inspect the nature and extent of the damage. The observations that one was able to make casually from the road, left on the mind a feeling of dismay at the gravity of the visitation and sympathy for the farmers who have suffered very heavy loss, especially as several of them, we hear, are either not insured or only partly so. In some cases the damage is put as high as £1000 or more, and many others run into hundreds. In Oakley alone some estimates put the damage at close upon £3000, and Mr. Hartop has suffered severely. As usual the storm played some invidious freaks, such as destroying a crop on one side of the road, and leaving the fields on the other side comparatively unharmed. Two curious cases came under notice. On one farm the crops were covered by insurance except as to a field of beans, and it was the beans that suffered very badly. In another case where all the crops were insured except the beans, it was only the beans that escaped. Some men are born lucky, some achieve luck, and more have bad luck thrust upon them. Nevertheless, putting the best complexion on it, it is a very lamentable business, which will call for that forbearance and practical sympathy which we hope those who are in a position to show it will extend to the sufferers. Many people went out from Bedford on Saturday and Sunday to see for themselves the devastation of which they had heard, and specimens were brought home of ears thrashed out, bean pods torn open, and mangel leaves mangled only too sadly, which formed the subject of conversation and of narratives circulated in the market.

Little Staughton.—The centre of the storm, which covered a belt of country some eight or nine miles long, and about two miles wide, is said to have been near Little Staughton. The Rev. Alfred Hancock said that the hailstones that fell at Little Staughton were of extraordinary size. Some were quite 5 ins. in circumference, and others would just cover a five-shilling piece, but most of them were heavy, pear-shaped stones. The onslaught of the storm was sudden. Just before nine o'clock, as he sat in the rectory waiting for the thunderstorm, which every one was expecting, Mr. Hancock heard a noise as of a brickbat crashing through one of the back windows, which face the west. A moment later it seemed as though the house were being battered down by a bombardment. The windows were smashing all over the back of the house, and they could hear crashing sounds in the garden. For six or seven minutes the storm raged, and then it ceased as suddenly as it had begun. Half of the long straggling village of Little Staughton lay across the path of the storm, and in this half hardly a pane of glass which looked westwards was left unbroken. Some farmhouses had eighty panes broken. The church, which occupies a rather exposed position, suffered severely, no fewer than 162 panes of glass having been smashed. Curiously enough, the last really severe storm in the district, six years ago, damaged the church also, but on that occasion the spire was destroyed, and the church partially wrecked by the lightning. On all sides farms and fields and gardens have suffered appalling damage, most of the corn being completely destroyed. On the farm of Mr. Henry Banks, for instance, three fields of corn, which had promised an abundant harvest, were left absolutely worthless. The corn had been swept right down, the straw had snapped short, and the hail had threshed the corn till all its grain lay in little heaps on the damp soil. Fifty ears of wheat picked at random failed to produce a single grain of corn. Field after field had been ruined in this ruthless fashion all round the district. Mr. Banks's loss, it is said, is more than £1000, while other farmers who occupy smaller holdings in Staughton have suffered to the extent of more than £500 each.

Keysoe.—At Keysoe many windows were smashed. In Mr. J. George's house 108 panes were broken, in Mr. T. Stanton's 45, and in one of the cottages 29 panes. Throughout the village were many hundreds. Mr. Rogers, of Ravensden, was taking out his horse from the van at the Chequers Inn when the wind caught the van and blew it across the road, throwing it on its side in the ditch. The more serious results, however, are the destruction of the crops, particularly at Keysoe Row, where the full effects of the storm may be seen. Along the Row are a number of small farms, besides several large ones. Messrs. T. Stanton, J. George, B. Hawkins, G. James, G. Beeby, T. Asher, W. Gillett, E. Woolston, T. Matthews, F. Ruff, J. Whitlock, T. Wagstaff, and J. Brown are among the greatest sufferers, some having their produce destroyed, and with others the destruction is complete. The straw is literally cut to pieces, and the corn entirely thrashed out. The College Farm (Mr. W. Hartop's) has not suffered so severely as some, but his adjoining farm (Mount Pleasant) is practically ruined. The experience of his brother (Mr. B. Hartop) is much the same, the home farms being partially injured, whilst the crops on his farm at Thurleigh are entirely destroyed. On the Grange Farm (Messrs. E. and C. Walker) the damage is comparatively light, the more serious damage being on their farm at Little Staughton. A large quantity of clover seeds is destroyed, as also the root crops, which are cut off to the ground. The gardens of Messrs. E. Bayes, J. Hayter, and F. Freeman, which are usually a credit to the village, are completely destroyed. Tomatoes, kidney beans, marrows, cucumbers, winter greens, and flowers are cut off to the ground. One does not wonder at the damage wrought, Mr. E. Bayes on Friday measuring a hailstone 2¾ inches in circumference, and bushels of stones (many larger than marbles) were lying in the School grounds twenty-four hours after the storm. In addition to the loss of harvest work, many men have lost the produce of their allotments, and probably the disastrous effects of the storm will be felt most keenly by the smaller farmers.

Stagsden.—Between 8.30 and 8.45 p.m. a hailstorm, such as has never been known in the memory of man, coming from the south-west, accompanied by rain and thunder and lightning, burst with wonderful velocity, breaking all windows exposed to that quarter. Practically every house in the village and out-ends have broken windows. The leaves and boughs were blown off trees, and had to be carted away from roads on Friday. Apples were blown from the vicarage garden into the bedrooms of the houses across the road. The vicarage and church windows on the west, glass-houses, plants and flowers were dashed to pieces by the hailstorm, all in about a quarter of an hour, and the hailstones were larger than walnuts. Some were found to weigh an ounce. The shops in the village on that particular side were badly used, sweets and other stuff being utterly spoiled and bottles broken. The chapel windows were broken. A hen-house near Northend Farm was blown some distance and thrown into the brook. A number of chickens were drowned or otherwise killed. The orchard at Northend is almost uprooted. Mr. Dimmock's horses broke open the gate and dashed away some distance. The cries of the sheep and lambs were most pitiful, and the animals were beating against the gates to get away anywhere. The corn, which on Thursday afternoon stood just fit for the binder, is now in a state of devastation, meaning hundreds of pounds loss. Beans are threshed right out, oats are cut several times on one stalk. Everywhere is in a state of ruin. Fortunately nobody was hurt, nor stock injured.

There are only two farmers in the parish, Mr. H. Newman and Mr. S. W. Lockhart, who are insured against hail. The loss here is estimated at about £5000. Rabbits, birds, poultry, and partridges have been picked up dead, with legs and wings broken. Mr. and Mrs. A. J. Whitmee were driving home from Bedford, and on Bromham Bridge they could scarcely breathe for the velocity of wind and close atmosphere; the pony made a bolt and pulled up at Bromham Swan, where they took shelter. Both received bruises about the face and hands and arms. Mr. Whitmee's eye-glasses were broken on his nose.

The storm seems to have taken a two-mile track from the west over the village, extending from the outskirts of Turvey to Stagsden West End by the brook. Within this zone it is one appalling scene of devastation, and in many cases it is impossible to estimate the damage. In places the storm showed a partiality, one half of a field being literally wiped out and the other practically untouched. Where barley was a little green the ears had been cut clean off and the stubble left standing. Winter beans, which were fairly ripe, are thrashed out and cut right down. Spring beans are not hurt quite so much. Some of the wheat crops are ruined. Mr. R. Wells estimated his damage at over £600, his Up End Farm having suffered most. Mr. Wright has suffered as badly as any one, and the loss on his 300 acres is estimated close upon four figures. That part of Mr. Lewis Walker's farm in the Newport Road side of the house is seriously damaged, but on the Kempston side he has escaped with slight hurt. So fierce was the wind that tops of many trees were broken off, and tons of branches lay on the ground. Mr. Fensome had a hen-house blown into atoms, and all its occupants, about fifty, killed by the hailstones. Mr. Lockhart's horse-hovel had a side blown out and every tile broken. The glass of the vicar's greenhouses was smashed, and his beautiful gardens completely wrecked. It is estimated that about 1400 panes of glass were done for in his glass-houses, while the church and school windows on the west side were nearly all broken. Mr. B. Howkins's farm at West End came off badly on the Stagsden side of the brook, but escaped very well on the Kempston side. The working men have been no more fortunate than their masters, the cottage gardens and the allotments suffering as much as anywhere. It was a curious sight to see the windows of the cottages barricaded with corrugated iron, sacks, boards, etc. Hail was six inches deep in places next morning. A lamp in the schoolmaster's house was knocked over and put out, and a lamp in the middle of the school was broken by hailstones. We understand that nearly all the farmers of Stagsden were uninsured.

Thurleigh.—Almost every house in the village of Thurleigh had the windows broken, and much damage has been done to the property. It has left the village in a most dilapidated state and unrecognisable. For two miles around there has been serious damage. The farmers say that their crops are utterly destroyed. Certainly they are cut about in all directions. Beans and oats are stripped from what would have been good returns. The aged people in this district state that they never knew such a storm in their history, and they hope there will never be another. There has been much damage done in other parts near this neighbourhood.

Milton Ernest.—Some of the hailstones were as large as walnuts and damsons, and they did great damage to the corn and other crops. With the exception of two or three crops west of the village, towards Radwell, the whole of the crops in the parish were ruined. The oats and barley appear to have suffered most, being almost a complete wreck. The corn was cut and broken about, and the wheat that was ripe or nearly ripe is threshed out almost as clean as if it had been put through a machine. The backward wheat is cut about and the straw bent down, but not so completely wrecked as the riper wheat. Beans also suffered badly. The root and potato crops look as if a flock of sheep had been feeding on them and left nothing but damaged roots and stalks. Fruit and fruit trees suffered a good deal. A large crop of plums on a magnificent tree at the west end of the schoolhouse was completely ruined. Nearly every window in the village facing west or south-west was broken, in some cases only a pane or two, but others completely shattered. Mr. Hull had 146 panes of glass broken, Mr. Street 52, a stained glass and two other windows were broken in the church, and also some of the chapel windows. The vicarage windows and those at Milton Mill and Milton House, the residence of Mr. Whitaker, suffered very severely. The garden produce in the village was practically all ruined. On the Milton Hall estate three large trees on the side of the road were broken down, and the trees generally in the track of the storm had many of the top boughs broken off. The road was strewn with leaves and branches. A good many partridges were killed by the hail, and in the woods nuts were strewn all over the ground. The loss sustained by the farmers and allotment holders is considerable, and we learn that only Mr. Street is insured against damage by storms at Milton Ernest.

Cranfield.—The damage done by the hailstones and the wind was very great. Bourne End and the parts nearer Astwood and Stagsden seemed to have caught the greatest violence of the storm. Mr. Mitchell's greenhouse was completely wrecked. Mr. Grimes and Mr. Bilton, of Bourne End, had sustained loss to the crops to the extent of about £100 each. Mr. Cranfield, of Astwood, whose farm adjoins these, has suffered about £500 damage.

Bromham.—The storm has left a scene of devastation such as has not been experienced in Bromham in living memory. The lightning was magnificent, but the cause of the great damage in the fields and gardens was the tremendous hailstones, many being as big as pigeons' eggs. All the gardens and fields have suffered, and one farmer alone estimates his loss at over £1000. The splendid gardens of Mr. W. H. Allen, Bromham House, have suffered terribly, and presented a pitiable sight next morning. Everything seemed ruined, flowers, fruit, and vegetables; while hundreds of panes of glass in the numerous glass-houses were broken.

The Structure of Hailstones.

Mr. D. S. Landis, of Fort Worth, Texas, has communicated the following interesting note to the U.S. *Monthly Weather Review* for June 1906:—

"On the evening of June 20, the observer at Fort Worth had an unprecedented opportunity to examine hailstones with reference to the formation of the centres. The hail fell for fifty minutes, and the stones were plentiful for several hours after the storm had passed. The hailstones of this storm were very symmetrical, the prevailing form being an oblate spheroid about two and a quarter inches in the long diameter by one and three-quarter inches in the short axis. The largest stones had nine definitely marked concentric layers outside of the central nucleus. Three other styles of formation were in evidence, viz. those having three, five, and seven layers. These layers were distinguishable by being cemented, or congealed, together by sheaths of a thin, white, amorphous ice so devoid of thickness as not to be called a layer, yet in the cross sections the lines of separation were as well marked as those of the layers of an onion.

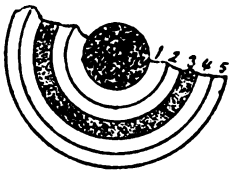

FIG. 1.

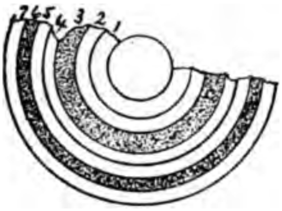

FIG. 2.

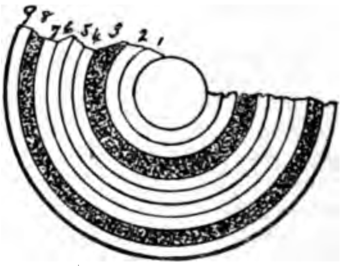

FIG. 3.

FIGS. 1, 2, and 3 show the formations of Hailstones, having five, seven, and nine layers respectively, outside the central nucleus. The stippled portions represent snow of a definite form, granular in a few instances, but not compact, as amorphous ice usually appears.

"It was noted that every stone had an odd number of layers in its formation, the series running three, five, seven, or nine layers. The outside surfaces of all stones were quite smooth and of crystal ice. In the seven- and nine-layer hailstones, the layer next to the surface layer was snowy, something of the nature of a snowball dipped into water and slightly compressed, forming a sort of mushy, amorphous ice, usually very white. In the five-, seven-, and nine-layer formations, the third layer, counting from the nucleus outward, was an enwrapment of snow so definite in structure as to admit of no doubt of its being moist snow. This third layer was about as thick as heavy blotting-paper. In the seven- and nine-layer formations the nucleus and all layers were crystal ice, excepting the third and the layer next to the surface layer.

"In the five-layer formations there were variations from the seven- and nine-layer stones, *i.e.* the five-layer formations always had a soft centre or nucleus of either amorphous ice or snow. In two instances the centres presented such feathery frost-needles that the contents could be shaken out by gently tapping the ruptured stone with a lead-pencil, leaving a spherical cup of crystal ice, ragged and pitted within.

"Another feature of this hailstorm, probably having some significance with reference to the altitudes at which these hailstones had been formed, was that at intervals of about ten seconds from the time a loud peal of near-by thunder was heard, there would be a downpour of nine-layer hailstones, followed two seconds later by an increased shower of the seven-layer formations, and one second after these came the five-layer formations, immediately followed by the small three-layer pellets of ice.

"During the storm the wind was blowing a gale, and the direction of descent of all stones was the same, except for the nine-layer formations. At intervals only, these came from a direction almost opposite to the course of the wind; the remainder of the time they came quartering with the wind. During the reverse action of the stones against the wind the descent was at an angle of about 60°, but at other times the descent was more nearly perpendicular.

"The test for the presence of air within the stones showed that whenever a snowy or amorphous layer was reached air bubbles were in evidence. No air bubbles were given off from the three-layer stones, nor from the centres of the seven- and nine-layer formations. Whenever the five-layer centres were reached air bubbles were present, plainly showing the presence of enlocked air.

"The snowy centres of the five-layer formations seem to have originated in a snow zone. The other nuclei must have been formed without the snow zone. The snowy layers or amorphous conditions noted in the seven- and nine-layer formations indicate that the snow zone must have been passed twice.

"In view of the observations made during this hailstorm it seems wrong to assert that the centre of a hailstone is either crystal ice or amorphous ice. It seems that the centres or nuclei are variable quantities, dependent upon the conditions of temperature and moisture, and the altitude at which the nucleus forms. With these factors in mind, it is evident that the centre of one stone might be crystal ice, another be amorphous ice, or mushy, like snow, while others can be dry snow, damp snow, or even frost itself."

Suggestions to Observers of Hailstones.

Prof. Cleveland Abbe, in the U.S. *Monthly Weather Review*, June 1906, referring to the preceding article by Mr. Landis, recommends that future observers of large hailstones should, if possible, note the following points:—

1. Examine many nuclei and ascertain what proportion of them are (*a*) clear ice, (*b*) dry snow crystals, (*c*) a mushy mixture of snow or ice with or without air bubbles.
2. Devise some method of approximately measuring the temperature of the nucleus, as distinguished from the outside layer. The difference of temperature between the inside and outside may be quickly ascertained by thermo-electric methods. The average temperature of a whole hailstone, as well as of its several parts, can be determined by delicate calorimetric methods.
3. Measure the volumes of the successive layers and the nucleus. This is best done by making careful drawings of sections of the hail before it melts, and measuring from these drawings afterwards at leisure.
4. Observe whether the air bubbles in the respective layers are elongated radially, or have any other systematic arrangement.
5. Note the time which elapsed between lightning and thunder and the fall of hail, if any, apparently attending them; the connection is undoubtedly purely accidental, and the observations should bring out this fact.
6. Split the hailstones carefully with a sharp knife, and note whether they have special planes of easy cleavage.

Hailstorm at Lewisham, June 25, 1652.

In *The Colfeian* (which is the Chronicle of the "Old Boys of Colfe's Grammar School, Lewisham") there is an account of the early history of the school from 1652. In this there is the following interesting paragraph relating to the damage done to the school premises by a remarkable hailstorm:—

"A fortnight after the school was opened a severe storm swept over the district, which is thus described by Evelyn in his diary: '25 June 1652 after drowth of neare 4 monthes there fell so violent a tempest of haile, raine, wind, thunder and lightning, as no man had seene the like in this age; the haile being in some places four or five inches about, brake all glass about London especially at Deptford and more at Greenwich.' The bill for the damage to the school windows will show the amount of destruction to a single house:—

The glaisrs bill.[1]

	£	s.	d.
For 6 gret panes Repared in the squll at 12d. a pane	0	06	0
For 4 panes Repared in the liberye at 5d. a pane	0	01	8
For 230 qures of nwe glas in the squll and liberye at 10d. a dusn	0	16	0
For putin in 78 qures of your one glas at 4d. a dusn	0	02	2
and nales	0	00	6
For 11 panes Repared in the dwellen hous at 5d. a pec	0	04	7
For 130 qures of nwe glas in the dwellin hous at 10d. a dusn	0	09	0
For nales	0	00	3
The sum is	2	00	2

"Endorsed by Mr. Colfe—'Geo. Hamond the glasier's bill for mending ye glasse broken with the storme of haile 25 June 1652—40s.'"

Beech Trees and Lightning.

In the *Quarterly Journal* for October 1906 (p. 295) there is a quotation from the *Electrical Review* of August 10, of six men sheltering under a beech tree during a thunderstorm. Two were killed, the others struck down insensible. There is no evidence whatever that the beech tree was struck, only that the men were bad conductors. One would like to know if the men had been running, if they were hot or wet, and if any of them were leaning against the tree. Possibly the tree was conducting properly, whilst the men formed "bad bridges."—J. P. MACLEAR, Chiddingfold, December 3.

Blue Hill Meteorological Observatory, Mass., U.S.A.

As twenty years have elapsed since the opening of the Blue Hill Observatory on January 30, 1885, Mr. A. Lawrence Rotch, the Director, in the recently issued volume of *Blue Hill Meteorological Observations*, 1903-1904, gives the following review of the principal work done there:—

Blue Hill was one of the first stations in the United States to be equipped with many self-recording instruments, and at the present time it is one of the few in the world where nearly every element observed is continuously recorded. Unlike most stations in this country, the standard instruments at Blue Hill, their location and environment have remained unchanged, making the records strictly comparable. In 1891 the hours for the eye observations were changed from 8 a.m., 3 and 10 p.m., to 8 a.m., 2 and 8 p.m., in order to conform to the hours adopted by the Weather Bureau. The tabulation and printing of hourly values of atmospheric pressure, air temperature, relative humidity, precipitation, wind direction and velocity, were begun in 1886, when almost no such data existed in the United States, and until 1895, inclusive, hourly values for several of these elements were published annually. The hourly amount of cloud, observed directly in the daytime and recorded automatically at night, was published for ten years, and constitutes the most complete record in this country. The "Blue Hill Observations" for 1889 were printed in the international form in general use abroad but not before employed in the United States. Two years later the practice of giving metric equivalents for the English units in the summaries of observations was adopted at Blue Hill, and in 1901 all the data were given in metric units.

Local weather predictions were begun soon after the establishment of the

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[1] Add. MS. 10602, British Museum.

Observatory. For this purpose the weather conditions prevailing over the United States each day at 7 a.m., 75th meridian time, as reported telegraphically by the United States Signal Service, were charted in Boston, and beginning in May 1886, this chart was manifolded, by means of an apparatus furnished by Mr. Rotch, within four hours after the observations were made, whereas the similar chart lithographed at Washington arrived 36 hours afterward. From this synoptic chart, which a messenger brought to the Observatory, and from the local indications, forecasts for Boston and vicinity were prepared and furnished to the Associated Press until 1891, when the newly organised United States Weather Bureau began the issue of local predictions in Boston to supplement the general ones sent from Washington.

The kind, level, amount, density, position, direction of drift, and relative velocity of clouds have been observed several times daily since 1886, and for nine years were published *in extenso*. In 1890-1 the first trigonometrical measurements in this country of the height and absolute velocity of cloud drift were made at Blue Hill, and they were repeated in 1896-7 as part of an international system.

The exploration of the air by means of kites lifting instruments which record continuously was originated at Blue Hill in 1894, with the aid of Mr. W. A. Eddy, and the appliances developed here have been generally adopted elsewhere. In 1901 the first observations above the North Atlantic Ocean were obtained by Messrs. Rotch and Sweetland with kites flown from a transatlantic steamer. The recent use of this method at sea, and the first observations with balloons at great heights above the American continent, have already been mentioned. In 1899 kites were used on Blue Hill to elevate the terminal wires in Marconi's system of space telegraphy, and signals were transmitted to a town in Cambridge twelve miles distant.

The observations for 1885-6 were privately printed, but subsequent observations have been published in the *Annals of the Astronomical Observatory of Harvard College*, vols. xx. xxx. xl. xlii. and xliii. The investigations have appeared in the *Annals*, in *Bulletins* issued by the Blue Hill Observatory, and in scientific journals.

The material growth of the Observatory may thus be summarised. The summit station has been twice enlarged, the total cost of the building being about $13,000, and two secondary stations have been established in the lowlands. The scientific staff, which formerly consisted of two persons, has been doubled, and the expenses of maintenance have increased from $2500 to $5000 a year. A library of about 8000 volumes and pamphlets has been accumulated.

The purpose for which the Observatory was founded and the main object of its existence is scientific research, free from prescribed duties and with an independent head. For this reason it has been possible to undertake work which could not legitimately be attempted by the Government service unless success was probable. Intimate relations with foreign meteorologists and institutions have been cultivated, and to this end the Director has attended the Meteorological Conferences held in Europe, and the meetings abroad of the International Cloud Commission and of the Commission for Scientific Aeronautics, of both of which he is the American member, and has endeavoured to carry out their resolutions and recommendations.

Errors of Absorption Hygrometers.

Mr. S. P. Fergusson has made a comparison with several forms of absorption hygrometers, and in the *Blue Hill Meteorological Observations*, 1903-1904, he has given the result of his investigations.

In the construction of hair hygrometers the best results are obtained by the use of fresh "live" hair. The scales of hygrometers of fixed proportions, such as those of De Saussure and Koppe, do not require readjustment when hair that has become unserviceable is replaced by hair from the same source. In instruments the proportions of which are not fixed, such as the hygrographs of the Richard-Klinkerfues pattern, it is necessary to re-determine the scale-values when the hair is changed or the relative positions of the cams altered in any way.

Relative humidities obtained simultaneously from several good hair hygrometers apparently agree more closely than those obtained from observations of the psychrometer and reduced by different methods.

Horse-hair hygrometers, while not so sensitive as human hair instruments, are excellent substitutes for the latter, because of their greater durability and of the greater ease with which they can be constructed. This remark applies more particularly to recording instruments.

The scale-values of hygrographs can be determined at low humidities quite easily by the high temperature method. It does not appear, from the experiments made, that the efficiency of the hair hygrometer is impaired by subjecting the instrument to temperatures not exceeding 50° C. (122° F.). It has not yet been determined whether the action of these instruments is the same at great heights in the air as it is at the ground. Comparisons of records from a recording psychrometer and a hygrograph while both instruments were carried aloft by a kite would, without doubt, settle this question.

In all comparisons of hair hygrometers with psychrometers the errors of the latter and of the formulæ of reduction should be considered; for, excepting the change of zero to which hair hygrometers are liable, the errors of these instruments are not greater than those of the psychrometer.

Rykatchew, in discussing the observations of a number of hair hygrometers, states that the readings at any time depend upon the humidities to which the instrument had been subjected, *i.e.* that the values given are too great after a dry period and too small after a damp one. This is practically confirmed by the records at Blue Hill, where, in every instance of a sudden rise of humidity to 100, the hygrograph rose slightly beyond 100, then fell slowly. That this phenomenon may be partially mechanical is shown by the fact that when the records are changed at a time when the humidity is 100, the pen begins its trace at a point as high as when it originally rose to 100. It would seem that an average correction for this error could be determined from a long series of observations. In a number of instances I have noticed that an instrument exposed after protracted disuse required a long time, sometimes one or two days, before its efficiency became normal. No explanation is suggested, except that the action is at first impaired by dust, which gradually disappears with use.

The testing apparatus could not be employed for measurements of the sensitiveness of hygrometers at very low temperatures, this problem presenting unusual difficulties. Experimental apparatus for approximate measurements has been devised, and will be employed during the coming winter. From a consideration of all the data at hand it appears that the sensitiveness of the hair hygrometer decreases at very low temperatures, and that the records obtained in the upper air by means of sounding-balloons are probably only coarsely approximate.

It is very greatly to be desired that the same method of measuring the humidity of the air should be adopted everywhere; for, until some standard method is employed, international comparisons will be of small value. Uniformity in methods of obtaining and reducing observations of the psychrometer is of the greatest importance.

The Insolation of Switzerland.

A note in *La Revue Générale des Sciences* for May 30 gives an abstract of a recent Swiss paper containing a summary account of the amount of sunshine registered at seven typical stations during the years 1891-1900. The stations were Berne and Basel, as representing towns placed on a plateau traversed by a river; Lausanne and Zürich, as representing towns beside lakes; Lugano, as a station in the southern Alps; Davos, as a high Alpine station; and finally the summit of the Säntis, a height of 8200 feet.

The results are as follow:—

At Basel and Berne the mean annual amount of sunshine registered is respectively 43 and 42 per cent of the possible amount; the maximum being in August, and the minimum in November in Basel and in December in Berne. From January to April there is a rapid increase in the insolation, while in May there is a sensible diminution. Zürich and Lausanne show a similar curve, with means of 43 per cent at Zürich and 47 per cent at Lausanne. The maximum is again in August in both, the minimum in January in Zürich and in December in Lausanne. At Lugano the conditions are somewhat different: there are two maxima (the first in July with 69 per cent, and the second in February with 60 per cent) and two minima (May with 51 per cent, and November with 42 per cent). The mean annual percentage is 59.

At Davos there are similarly two maxima (the first in August with 60 per cent, and the second in February with 55 per cent) and two minima (May with 47 per cent, and January with 49 per cent). The mean annual percentage is 54. At the summit of the Säntis the maximum is in November (51 per cent) and the minimum in June (35 per cent). The mean annual percentage is scarcely 42, this being explained by the fact that on mountains there is winter insolation: in the summer the summit is clothed in fog and cloud on account of the elevation.—*Scottish Geographical Magazine*, October 1906.

Climate of the Niger Basin.

The November number of the *Scottish Geographical Journal* contains a paper by Capt. C. H. Foulkes, R.E., on "The New Anglo-French Frontier between the Niger and Lake Chad." Capt. Foulkes makes the following remarks about the climate of the district:—

"During the dry weather, *i.e.* for one half of each year, the climate is comparatively healthy, excepting on the banks of the Niger and on the marshes bordering Lake Chad; but in the rains it is very unhealthy, and is similar to that experienced throughout the year on the coast. In the moist heat, Europeans become anæmic and enervated, and almost invariably suffer from malarial fever, and often from dysentery.

In November the dry season commences, and the temperature rarely rises above 95° (in the shade) during the day, while at night it falls as low as 40°.

The air is impregnated with fine dust borne by the Harmattan, an extremely dry wind, and owing to the haze thus caused it is often difficult to see objects only a quarter of a mile away; while at night the stars are often completely hidden, and even the moon is sometimes invisible.

In about March the temperature rises rapidly. The thermometer sometimes registers a maximum of 115° in the day, while at night the temperature is often as high as 95°.

May is the month of tornadoes, and these are often of extreme violence, though ample warning is always given of their approach. The air is breathless for an hour or two previously, and the heat of the sun is almost intolerable. Presently there is a stampede of natives running to the nearest shelter, and a mile or two away (generally to the north-east) the storm can be distinctly seen sweeping across the plain, its progress being marked by bushes and trees bent over almost horizontally by the wind, and a long line of churned-up sand. For a quarter of an hour the wind howls and plays havoc with every loose article left out in the open, and fine sand penetrates even "water-tight" tin cases.

Later on, these sandstorms are invariably and immediately followed by rain, which falls very heavily for a few minutes.

Following the tornado season come the regular rains, in which thunderstorms are frequent. These often provide a magnificent spectacle, and sometimes hang directly overhead for an hour at a time. Deafening peals of thunder occur simultaneously with the most vivid flashes of lightning, and rain falls in torrents. The sandy soil becomes quickly saturated with water, and river-beds which a few minutes previously had consisted of loose sand, feet deep, are now swirling streams capable of carrying a man off his feet and depositing him in some distant flooded hollow.

As the season advances, the rainstorms decrease in violence and give place to steady downpours, the rainfall becomes smaller and smaller, and the dry season gradually sets in. Pools of water (*tubkis*) which have formed in shallow depressions of the ground—the temporary haunts of numbers of wild ducks and geese—disappear, and no surface water is to be seen anywhere. Even the larger rivers, which throughout the whole of the wet season ran two or three feet deep, dry up, and the only water obtainable is from deep wells in or near the villages. These latter are usually found five or ten miles apart, but sometimes they are separated by forty or fifty miles of waterless 'bush.'"

Wellington (New Zealand) and Wind.

The capital of New Zealand is one of the windiest cities in the world, as it catches the full strength of the gales which blow along the channel that separates the two main islands. The Australian newspapers in their cartoons on New Zealand affairs always picture the people of Wellington holding their hats on their heads.

Effect of Drought in 1906.

The already long list of Roman Villas unearthed in this country has been added to rather curiously near Colchester.

In August last, during the extreme dryness of that period of the summer, a number of broad lines gradually appeared in the turf which slopes down to the river Colne, a little way within the Roman Wall. Further investigation showed that the outlines thus marked out by the drought were those of the foundations of a Roman Villa.—*The Globe.*

An Indian Rainfall and its Result.

A few years ago there was a serious flood on the East Indian Railway, extending over seven miles of the line near Sahebgunge. The water lapped the bank until all the "ballast" was washed out, carried away a pier of a five-span 60-feet iron-girder bridge, and lifted off a couple of the girders, which it deposited three hundred yards down stream. Traffic was necessarily suspended and diverted to another route, but on the third day resumed to some extent, a steam ferry transporting passengers over the stretch of country under water. In the meantime the engineers were hard at work, and by the next day the road was sufficiently repaired to admit of trains being cautiously brought up to each side of the destroyed bridge, where passengers and luggage were transhipped by means of boats. This mode of working had to be continued for a month, when the bridge was repaired and opened again for traffic to pass over.

At the adjacent station eleven inches of rain were registered in twenty-four hours, and the downpour went on in the same style for two days.

The official report on the interruption of traffic states: "The flood was due to continuous heavy rain throughout the district. The East Indian Railway at this point follows the south bank of the Ganges at about two miles from it, and the whole of the drainage from the Rajmehal hills (40 miles to the south-east) crosses it and falls into the Ganges. This inundation caused great damage throughout the district, many villages being destroyed, and the loss of life has been estimated at between one and two thousand people."—*The Railway Magazine*, October 1906, p. 353.

Climate of Hebron.

Dr. A. Paterson, who is a Medical Missionary at Hebron, in Palestine, gave at a recent meeting of the Scottish Meteorological Society an interesting address on "Hebron and its Climate." Referring to the climate he said:—

An observer may, through intimacy with the varying moods and phases of his local weather, be able to give a general impression of the climate in a manner which statistics hardly bring out.

In respect to the wind, the annual frequency of each direction in days is:—

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
48	18	29	27	9	8	82	144

We see at once that the North-west is the predominant wind; but with it may be grouped all with a Westerly component, viz. South-west, West, and North-west, giving a total of 234 days. These are the winds which bring rain in winter, and they also blow steadily during the long dry summer season.

North Wind.—Biblical allusions to this wind are definite and interesting, representing it as three phases—wet, dry, and transitional. For example, Prov. xxv. 23 (R.V.), "The North wind bringeth forth rain; so doth a backbiting tongue an angry countenance"; and Job xxxvii. 21-23, which describes the clearing of a storm, with fine weather following: "And now men see not the bright light which is in the clouds; but the wind passeth and cleanseth them. Fair weather cometh out of the north." Of later testimony, Robinson's: "The North wind occasionally brings fair weather, though less commonly than from the East" (*Physical Geography, Holy Land*, p. 277). Observations at our station show that in winter the North wind is sometimes wet and sometimes dry, and in summer always dry; it is always cold or cool, seeing it blows from the mountains of Asia Minor and Lebanon, which are snow-clad.

By "transitional" is meant the phase in which the wind is veering from West to East. Thus in winter, by the time a Westerly gale, after blowing for several days in succession, has worked round to the North on its way to the East, the storm of rain it brought has blown itself out, though there may be at this stage some final showers. And in summer, when for days together the day wind is West and the night wind East, the North is only a transient phase of the veering of the wind in the evening as the South is in the morning.

South Wind.—In the transitional phase the South wind is very prevalent—much more so than appears from the records, because it is badly timed for actual observation, viz. early morning. Though often a hot wind, it has never in the thirteen years of my residence at Hebron been there the scourge that it is described by Robinson:

"More frequently in Palestine is the sirocco from the South or South-west, continuing for one day and often for more. We encountered it in 1838 three times in its full strength. (1) About 11 a.m. the wind suddenly changed from North-east to South, and came upon us with violence and intense heat, until it blew a perfect tempest. The atmosphere was filled with fine dust, forming a bluish haze; the sun was scarcely visible, . . . and the glow from the wind came upon our faces as from a burning oven. Often we could not see ten rods around us; and our eyes, ears, nostrils, mouth, and clothes were filled with the sand. The thermometer at noon was 88°, at 2 p.m. 76°. (2) On May 23 (near Hebron) the wind had been South-west all the morning, but about 11 o'clock it increased, and became at last a violent tempest, bringing the dust and sand from the desert, and filling the air so as to obscure the sun. The whole atmosphere became of a deep dun or yellowish hue. The thermometer at 10 a.m. and 2 p.m. was 86°; at sunset it cleared away with a wind from the North-west. (3) On May 30 (south of the Dead Sea) the mercury at sunrise was at 69°, with a cool and pleasant wind from the South-west; but by 10 o'clock the wind had become strong, the mercury had risen to 96°, and the heat of the sun was intolerable. At noon this wind was a fierce sirocco, which brought up a dense haze, and the thermometer had risen to 102°. At 2 p.m. it had sunk to 96°, and at sunset was at 76°, with a cool North-west wind, which soon cleared the atmosphere" (*Physical Geography, Holy Land*, pp. 279-80).

This daily rotation of the winds is probably referred to in Eccles. i. 6: "The wind goeth towards the South, and turneth about unto the North; it whirleth about continually, and the wind returneth again according to his circuits." Summer and winter, however, the wind steadies for the most part somewhere in the West; the next stablest being the East, though far behind. With the Mediterranean on the west and the desert on the east of the two long flanks of Palestine, it is perhaps only natural that the winds from these "airts" should be the most prevalent and stable, and that the North and South winds should be more transient.

West Wind.—Summer or winter, then, the Westerly winds (*i.e.* South-west, West, North-west, tailing off into North) blow during more than two-thirds of the time, and always bring moisture. In winter this moisture yields five months of rain; in summer it is often not in evidence during cloudless days owing to the great heat; though on many summer days as well as nights great quantities of high and hard cumulus and cumulo-stratus fill the sky; but at night, and in the early morning before sunrise, dense fog-banks or drifting scud that blot out the landscape and drench everything are common.

East Wind.—This is undoubtedly the next in frequency and importance to the West. It is with us the night wind of summer, and is not always a hot wind. About sunset, or later, a Westerly breeze which has blown during the day veers by North-west and North to East, and during the early forenoon it continues its way round the compass to West again. This will go on sometimes for several days in succession. But the true East wind, or sirocco (Italian for Arabic *sharkiejyeh*, or easterly), which blows sometimes for two or three days on end, is a different matter, and is akin to that described above from Robinson as blowing from the South; it has rarely been experienced in Hebron since I went there.

The references to it in Scripture are numerous. Job i. 19: "And behold there came a great wind from the wilderness, and smote the four corners of the house, and it fell upon the young men, and they were dead" (probably the collapse of a tent, and subsequent death by suffocation). Jer. iv. 11-12: "A hot wind from the bare heights in the wilderness, . . . not to fan, nor to cleanse" (the reference is to Jerusalem). Ps. xlviii. 7: "With the East wind Thou breakest the ships of Tarshish." Hos. xiii. 15: "An East wind shall come, the breath of the Lord coming up from the wilderness, and his spring shall become dry, and his fountain shall be dried up." Jonah iv. 8: "And it came to pass, when the sun arose, that God prepared a sultry East wind, and the sun beat upon the head of Jonah, that he fainted."

Far short of such extreme exhibitions of itself, the East wind can inflict intense discomfort and work much damage. Only once have I witnessed an exhibition at all approaching a typical sirocco, and then the atmosphere was like a London fog.

Rarely is the East wind a carrier of rain, but twice in thirteen years I remember wet weather which beat up from this side, so that we had to close our easterly windows, which may with impunity remain open during the heaviest Westerly rains. It has been suggested that a Westerly wind bearing clouds was met by an Easterly cold draught, which cut in below it, and bringing down the rain, drove it in this unwonted direction.

Rainy Season.—The usual progress of the rainy season is in a more or less regular series of alternations of wet and dry ; paroxysms, so to speak, of storms intermitting with spells of the finest weather of the whole year, the wet bursts being usually shorter than the dry intervals.

Take the following as an average example of our winter weather. After ten days or a fortnight of sunny weather, sometimes indeed cloudless, if the East wind has prevailed, suspicious-looking clouds appear on the western horizon, banking up from small beginnings : "Behold there ariseth a little cloud out of the sea, like a man's hand" (1 Kings xviii. 44). Gradually the wind rises, and the sun becomes completely overcast. This may take a day or two, or only a few hours. Usually, as long as this rising wind continues strong the clouds hold up, but a lull in its violence, for which we know to look, is quickly followed by torrents of rain.

Then for three days and nights, often more, up to ten days on rare occasions, the heavens are obscured, and a gale, unremitting and violent, drives all life underground and indoors. At last the wind moderates, the cloud-pall having meanwhile begun to harden, lift, and break up, and at ever-shortening intervals sun or stars begin to show as the clouds disperse. Next day breaks fine, or, if the wind has veered to East, cloudless. Then follows an interval—usually of a week or a fortnight—of the most wonderful weather, with brilliant and warm sunshine, balmy and invigorating air, and high and hard cloud-masses, brilliant and snow-white, or lovely mackerel, in the bluest of skies, which, ultramarine at night, make the moonlight a never-to-be-forgotten spectacle of loveliness.

Now all life revives, and as the weeks pass the grass seems to grow visibly and the lean cattle to fatten before one's eyes, while all manner of activities which were in abeyance during the storm—ploughing, sowing, building, every sort of outdoor labour—are again and at once in full swing, and traffic, which has ceased because of risk to life and limb of man and beast, is again on the move. Wherever the water can run off, the roads and tracks dry in an incredibly short time.—*Journal of the Scottish Meteorological Society*, vol. xiv. pp. 23-26.

RECENT PUBLICATIONS.

Annals of the Astronomical Observatory of Harvard College. Volume xxxix., Part II. *Peruvian Meteorology*, 1892-1895. Compiled and prepared for publication by SOLON J. BAILEY. Cambridge, 1906. 4to. 138 pp. and 5 pl.

Few systematic meteorological observations were made in Peru during the latter part of 1890 and throughout 1891. Observations were resumed at Mollendo (80 ft.) and Arequipa (8050 ft.) early in 1892, and at about the same time a station was placed at La Joya (4140 ft.), midway between the above stations, on the Desert of Islay. In January 1892, a station was established on the slope of Chachani, at an elevation of 16,650 ft., and in October 1893 another, on the summit of the Misti, at 19,200 ft., with auxiliary stations at 15,600 ft. and 13,300 ft. This system of stations was extended in 1894 by establishing stations at Cuzco (11,100 ft.), between the two great ranges of the Andes, and at Santa Ana (3400 ft.), to the east of the Andes, in the valley of the Urubamba, a tributary of the Amazon.

The present volume contains only the eye-observations at the stations ; the records of the self-recording instruments will be published later.

During the three years and nine months of the observations at La Joya, no rainfall greater than a trace (*i.e.* less than half a hundredth of an inch) was recorded.

Annual Report of the Director of the Philippine Weather Bureau. 1903 Part III., and 1904 Parts I. and II. Manila, 1905 and 1906. 4to.

The amount of matter published by the Philippine Weather Bureau is most extensive. Part III. of the Annual Report for the year 1903 consists of 1128 pages, and weighs over 9 lbs. It contains the daily observations *in extenso* from 44 stations. The hours of observation at the first and second class stations are 2 a.m., 6 a.m., 10 a.m., 2 p.m., 6 p.m. and 10 p.m.; and at the third and fourth class stations, 6 a.m. and 2 p.m.

Parts I. and II. of the Report for 1904 contain the hourly meteorological and magnetic observations made during the year at the Central Observatory at Manila.

Cape of Good Hope. Report of the Meteorological Commission for the Year ending 31st *December* 1904. Cape Town, 1906. Foolscap. 15 + 119 pp. and plate.

The number of observing stations in operation was as follows:—1 First Order, viz. Kenilworth, near Kimberley; 1 Subsidiary First Order, viz. the Royal Observatory; 69 Second Order; 28 Third Order; and 431 Rainfall stations.

The most notable features of the weather of 1904 were a severe and long-continued drought with an unusually cool summer and mild winter in the east and centre of the country, abnormally heavy rainfall and cool cloudy weather in west and south; a comparative absence of severe snow-falls (except in September), an unduly prolonged period of severe frosts, frequent thunderstorms, and a marked absence of heavy gales and severe hail-storms.

Climatotherapy and Balneotherapy. The Climates and Mineral Water Health Resorts (Spas) of Europe and North Africa. By Sir HERMANN WEBER, M.D., and F. PARKES WEBER, M.D. London, 1907. 8vo. 833 pp. 15s.

This volume is a third edition of *The Mineral Waters and Health Resorts of Europe*, much enlarged in respect to medical climatology.

Part I. deals with "Climatotherapy and Climatic Health Resorts." Chapters 1 and 2 are concerned with general climatology, and give a definition of climate, and treat of such subjects as—Temperature of the Air; The Influence of Light (*i.e.* Sunshine); Atmospheric Electricity; Moisture of the Air; The Influence of Altitudes; Atmospheric Pressure; Movement of the Air (*i.e.* Winds); Marine Climates; Inland Climates; Ocean Climates and Sea Voyages. The remaining chapters contain a description of the Climatic Health Resorts of Europe and North Africa.

Part II. deals with Balneotherapy and Mineral Water Health Resorts (Spas); and Part III. is devoted to the selection of Health Resorts and Therapeutic Methods and their various uses in the different chronic diseases and morbid conditions.

The book includes a copious Bibliography and very full Index.

This work is an important compilation on the subjects dealt with by the authors.

Cold Waves and Frost in the United States. By EDWARD B. GARRIOTT, Professor of Meteorology. U.S. Department of Agriculture, Weather Bureau, Bulletin P. Washington, 1906. 4to. 22 pp. and 328 charts.

This paper notes briefly the general distribution of the colder areas of the Northern Hemisphere, refers to general conditions that are associated with cold waves, and presents a chronological account of historical cold periods in the United States. It then summarises and classifies the more important cold waves and frosts that occurred from 1888 to 1902, and presents 328 charts which exhibit the meteorological conditions that attended the principal cold waves of that period.

Ergebnisse der Arbeiten des Königlich-Preussischen Aeronautischen Observatoriums bei Lindenberg im Jahre 1905. 1 Band. Herausgegeben von Dr. RICHARD ASSMANN, Direktor. Braunschweig, 1906. 4to. 29 + 144 pp. and 14 pl.

This contains an account of the establishment and equipment of the new Aeronautical Observatory recently opened by the German Emperor at Lindenberg, about 40 miles south-east of Berlin. No pains have been spared to make this the most complete observatory for investigating the upper air by means of kites and balloons. Ascents of kites and balloons are made every day.

The following are the mean temperatures at each level of 500 metres (1640 ft.) in the various seasons :—

	Winter.	Spring.	Summer.	Autumn.	Year.
Lindenberg 122 metres 400 ft.	33°·4	46°·4	65°·5	44°·2	47°·3
500 ,, 1640 ,,	30·9	41·7	59·4	41·2	43·2
1000 ,, 3280 ,,	28·4	37·2	54·1	36·9	39·2
1500 ,, 4920 ,,	26·4	34·7	48·6	32·9	36·7
2000 ,, 6560 ,,	24·4	30·7	44·1	28·0	32·9
2500 ,, 8200 ,,	23·9	27·7	40·1	25·7	30·0
3000 ,, 9840 ,,	...	...	35·2	21·6	27·0
3500 ,, 11480 ,,	...	...	30·9	16·3	...

Klimakunde. I. Allgemeine Klimalehre. Von Professor Dr. W. KÖPPEN, Meteorologe der Seewarte. Zweite, verbesserte Auflage. Mit 7 Tafeln und 2 Figuren. Leipzig, 1906. Small 8vo. 133 pp. 80 Pfg.

This is a very useful little book. The author begins with an account of the different factors which go to form climate, and then gives a description of the instruments and the observations, and also their discussion. He next deals with radiation and heat, and the physical conditions which affect the radiation in the atmosphere. He then touches on the distribution of temperature and of radiation over the globe, and finally deals with the moisture and rain which falls and shows how it is modified by land and water.

La Revue Néphologique. Par A. BRACKE. Mons, 1906. 8vo.

This is an eight-page monthly magazine containing notes on the observation of clouds. The first number issued was that for January 1906.

Our Heritage the Sea. By FRANK T. BULLEN, F.R.G.S. London: Smith, Elder, & Co., 1906. 8vo. 21 + 338 pp. and pl. 6s.

With a view to arousing interest as to the importance of the Ocean to England, Mr. Bullen has written a series of chapters dealing with its many sides. The book is divided into the following sections :—The Ocean as the World's Reservoir of Health ; The Winds of the Ocean ; The Clouds ; Ocean Currents ; The Tides ; The Ocean as a Source of Food Supply ; Ocean, the Universal Highway ; The Ocean as a Battlefield ; What the Ocean means to Great Britain.

The author has summarised in a very readable fashion the substance of many most important works upon the sea, and set the summary forth in the light of personal acquaintance, thus making the book genuinely romantic in the highest sense.

Reduction of the Greenwich Meteorological Observations. Part IV. Temperature of the Air as determined from the Observations and Records of the Fifteen Years 1891 *to* 1905 *made at the Royal Observatory, Greenwich, now collected and discussed under the direction of* Sir W. H. M. CHRISTIE, K.C.B., M.A., F.R.S. Published by order of the Board of Admiralty, in obedience to His Majesty's command. Edinburgh, 1906. 4to. 9 + 67 pp. and pl. 3s.

The present publication gives the results of a discussion of the temperature of the air made at the Royal Observatory, Greenwich, during the fifteen years 1891-1905, with a discussion of the extremes and means for the sixty-five years 1841-1905. It may be regarded as a supplement to *Reduction of Greenwich Meteorological Observations*, Part III., published in the year 1895, which dealt with the temperature of the air for the 50 years 1841-1890.

Full tables show the mean, the maximum, the minimum, and the daily range of temperature for each day during the 15 years. These are succeeded by other tables giving means, extremes, etc. By combining these with the results included in the earlier volume, the following particulars relating to the whole period of 65 years, 1841-1905, have been extracted:—

The earliest date in any year on which the maximum temperature of the year occurred was May 6, 1862, with a temperature of 81°·5 (the only occasion during 1862 on which a temperature above 80° was recorded), and the latest date in any year was September 24, 1895, with 87°·3. The maximum temperature during the 65 years was 97°·1 on July 15, 1881. In 1860 the maximum temperature did not rise above 76°·5.

The latest date in spring on which the minimum temperature occurred was March 26, 1850, with a temperature of 20°·0, and again on the same date in 1861 when 26°·1 was recorded. The minimum temperature during the whole period was 4°·0 on January 9, 1841.

The maximum temperature of the year occurred in the month of May in 4 years, in June in 11 years, in July in 32 years, in August in 16 years, and in September in 2 years.

The minimum temperature occurred in the month of January in 24 years, in February in 13 years, in March in 8 years, in November in 3 years, and in December in 17 years.

The number of days on which the temperature fell to or below the freezing point varied in the first half of the year from 11 in 1896 to 70 in 1855; and in the second half of the year from 2 in 1852 to 38 in 1879; or taking the whole year, from 17 in 1872 to 95 in 1879.

There were 176 days during the period 1841-1905 on which the temperature fell to or below 20°; of these the number in the month of January was 72 (10 of which occurred in 1881), in February 46 (10 of which occurred in 1855, and 11 in 1895), in March 6, in November 2, and in December 50. Of these 176 instances of low temperature, 133 were between 15° and 20° (including those of 20°·0); 33 between 10° and 15°; 9 between 5° and 10°; and only 1 below 5°, viz. 4°·0 on January 9, 1841.

The temperature rose to 90° and above on two days in succession on July 4 and 5, and July 31 and August 1, 1846; July 12 and 13, 1859; July 4 and 5, 1881; July 3 and 4, 1887; July 19 and 20, 1900; and on 3 days in succession on July 20, 21, 22, 1868; August 13, 14, and 15, 1876; and August 16, 17, and 18, 1893.

The earliest date in the year on which the temperature rose above 90° was June 16, 1858, with 94°·5, and the latest September 8, 1898, with 92°·1.

There were 55 occasions in the 65 years when the temperature reached 90°·0 or above.

Third Annual Report of the Metropolitan Water Board. Year ended 31*st March* 1906. London, 1906. 8vo. 12 + 119 pp.

Under the section "Records of Rainfall" we learn that the Board, at the close of the year under review, entered into an agreement with Dr. H. R. Mill, by which Dr. Mill has undertaken to make an extended and improved monthly report of the rainfall in the valleys of the Thames and Lea, accompanied by appropriate maps showing the distribution of rainfall during each month by means of "isohyetal lines"—that is, lines of equal rainfall—with such other information as to the monthly rainfall within the two valleys as the Water Board may from time to time reasonably require. Dr. Mill is also under obligation to make an annual inspection of all the rain gauges belonging to the Board so that they may be kept up to a proper standard of accuracy.

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WEATHER IN WAR-TIME.

By RICHARD BENTLEY, F.S.A., PRESIDENT.

[An Address delivered before the Royal Meteorological Society, January 16, 1907.]

> No kind of history so fascinates mankind as the history of wars.—HAMLEY.

> The darker the night, the more inclement the weather, the more disagreeable the surroundings, the more valuable the training will be, and our young soldiers will gain some glimmering of what they must expect to meet in war.—SIR JOHN FRENCH.

WHEN it is borne in mind that on fifty-six previous occasions the Presidents of this Society have in turn touched upon the various aspects under which Meteorology presents itself, it becomes increasingly difficult each year, when so many footsteps have gone before, to find a fresh path. Yet though more than half a century has elapsed in our annals it has chanced that no one has yet dealt with a very interesting phase in the history of weather, viz. the important part it often has in deciding the issues of war. A first impulse when the subject comes up is to refer to that masterly analysis of military campaigns, the late General Hamley's *Operations of War*, or to General Graham's *Art of War*, but, curiously, on each occasion only to be disappointed. Being ever present, the influence of weather in all branches of warfare is so self-evident as to be accepted almost without mention! In our own meteorological publications, too, the scientific aspect predominates over the historical.

This void then must be the excuse for the brief and imperfect notes placed before you to-night, in the hope that possibly they might some day prove of service if information is sought for on the topic. Owing to the limits of time at our command, the description of each event is necessarily much curtailed, and so loses much of its fuller interest; yet as an index only it will supply a key to any one hereafter wishing to refer to the detailed information. As a civilian, it would be impertinent of me to do more than narrate the actual facts, and I leave them for naval or military experts to draw deductions therefrom.

I do not propose to go back, though associated with warlike operations, to the time when the Israelites crossed the Red Sea[1] by aid of wind and tide; or to touch upon the prodigies of the heavens during the siege of Jerusalem by Titus; or describe the great comet which heralded the invasion of England by William the Conqueror;[2] or the other portents, the parhelia—the three suns at once—which appeared on the morning of the battle of Mortimer's Cross in 1461; or the dazzling meteor which shot across the sky the night before Cromwell's great victory at Dunbar; or the comet[3] which preceded the birth of the great warrior, Napoleon I.

One would digress again into the regions of astronomy to refer to occurrences such as the total eclipse of the sun mentioned in Herodotus, which brought to an abrupt termination a battle begun between the archers of the King of Lydia and those of the King of Media in 585 B.C.; or the hasty return home of the King of Sparta and all his men, engaged in fortifying the isthmus of Corinth, in 480 B.C., who were alarmed by a solar eclipse; or the lunar eclipse of August 413 B.C., which so perturbed the Athenian general Nicias that it caused him to suspend his retreat and thereby led to the destruction of his entire army; or the solar eclipse in May 1706 which discouraged the troops of Marshal de Tessé on their retirement from Barcelona upon Perpignan, the sun being the Bourbon emblem; or the eclipse on the day that the Portuguese Royal Family left Lisbon, "when the House of Braganza ceased to reign" in Europe (for a time).

The illustrations of weather selected amount to about 362—241 of which principally concern military operations, and 121 naval.

The effects of rainfall, hail, snow, heat, thunder, and earthquakes fall into the military category; those of calms, contrary winds, invasions, and personal adventures afloat, into the naval. Battles during storms are equally divided. In operations in fog or on ice the military incidents preponderate, and in operations in high winds the naval predominate.

RAIN.

Coming first to rainfall:—

It was in the swamps of Lippe, near Bielefeld, in Westphalia, in A.D. 9, that the three Augustan legions perished under Quintilius Varus, the first Roman Governor of Germany. He had previously been Governor of Syria, but was no match for the craft of the Germans, whose pretended friendship caused him to disperse his troops in distant detachments. The three legions in question were on the march over the difficult country of the Teutoburger Wald to quell a distant rising, preconcerted to further separate the Roman forces. A long period of wet weather had set in, and the fenland around the sources of the Ems and the Lippe was sodden and impracticable for cavalry or wagons. It was while endeavouring to construct a firm causeway along the low ground between the wooded hills that hostilities suddenly began, before the

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[1] In 1798 Napoleon I. crossed the Red Sea dry-shod at the same spot, but was nearly drowned by the flowing tide on his return.

[2] This was Halley's comet, which reappears about 75½ years apart. It is next expected to be visible in 1910.

[3] Its periodicity is about 2000 years.

Romans were able to fall into battle formation. The legionaries, however, were able to repulse the onset of the German hordes and form camp for the night. On the next day Varus resolved to destroy his heavy baggage and push on through the hill passes to the strong fortress of Aliso on the Lippe. In the face of constant attack by the agile forces of Arminius, Varus endeavoured to continue his advance, struggling with difficulty over the clogged, heavy ground, the toil and discomfort of his men aggravated by the heavy torrents of unceasing rain, which caused the remaining provision-wagons to stick fast and many to be abandoned. Retreat was as impossible as advance, and, gradually hemmed in on all sides in a most unfavourable position and rendered helpless by the weather, the Roman forces, just as they were emerging from the wooded hills, were massacred. Varus himself committed suicide. Six years elapsed before Germanicus recovered the eagles of the legions. Eighteen hundred and seventy years passed before the British experienced a similar disaster at Isandlwana at the hands of the Zulus.

When the Scots crossed the border and invaded Northumberland in 1093, Malcolm the Third of Scotland was defeated near Alnwick and his army routed. It was a very wet winter, and the floods in the valleys barred a retirement, so that large numbers of the invaders were cut off and put to the sword.

In a premature attempt to seize the crown of England, Henry the Seventh's standard was hoisted by the Duke of Buckingham at Brecon in October 1483. Owing to the elements, after a ten days' struggle the attempt failed. Through heavy rains that autumn both the Wye and the Severn were so deep in flood (and Richard's forces held all the fords) that Buckingham was cut off from his allies in the Midlands, and Henry's own expedition met with equally bad weather and was blown back to France. This downpour and flood was long remembered as "the Duke of Buckingham's Water."

At the siege of Baza in Andalusia in the reign of Ferdinand and Isabella, in 1489, a fearful rainstorm took place, and the torrents sweeping down from the mountains washed away the camp of the Spanish sovereigns, and tore up the approach roads so that the convoys to feed the investing army were interrupted. The troops, driven out of their tents, suffered greatly, and much sickness ensued.

In 1503 the Spanish army in Southern Italy experienced shocking weather. When on the Garigliano the men were frequently marching knee-deep in water. The whole country is described then as a quagmire or standing-pool. Those on the higher ground were in scarcely better plight. The driving storms of sleet and rain, which had continued several weeks without intermission, found their way into every crevice of the flimsy tents, or crazy hovels thatched rudely with branches of trees, which served as shelters for the troops.

In 1527 the Connêtable de Bourbon crossed the Trebbia to meet his death at the sack of Rome. It was March, and heavy snow and rain stopped his advance. A fortnight later the same conditions still obtained. Constant obstacles hindered his progress. Sleet and rain had fallen in great abundance, rendering roads and rivers alike impassable, and the transport of heavy guns impracticable. Leaving their artillery at Siena and forsaking the main road, the Spaniards and Germans with incredible labour threaded their way by bridle-paths and mountainous defiles. It was May before Rome itself was attacked. The morning rose heavy (says Dr. Brewer), with clouds and fogs hiding from the citizens the advance and manœuvres of their foes, and consequently their artillery proved of little use in holding them in check. At the third assault the Constable was struck down mortally wounded. More thick and murky fell the mist, hiding from each other assailants and assailed. About two in the afternoon the Spaniards carried the ramparts by a desperate effort and entered the city. No quarter was given, no sex and no age was spared. "The dark fog prevailed all day," said an eye-witness.

It was in the spring of 1529 that Solyman (or Solomon) the Victorious and Magnificent set out from Constantinople for the conquest of Vienna. A season of almost unintermittent rain made the march of the Turkish army to the Danube very laborious and slow, and supplies difficult to carry or even to get. Thus the Austrian Governor, Count Salm, had an opportunity for ample preparation, and September arrived before the Turkish cavalry swept round the walls of the city and the Commander of the Faithful pitched his tent on the heights of the Soemmering. Fortunately for the defenders, the incessant rains during the summer had compelled the Turks to leave their heavy siege artillery behind in Hungary, the tracks being only passable for the lighter pieces. The Ottoman forces suffered much during the siege both from scarcity of provisions and by the continued inclemency of the season, and one midnight in October the tents of the invaders were struck—the great siege of Vienna was over, and the Sultan was in retreat to the shores of the Bosphorus.

On October 18, 1541, the Emperor Charles the Fifth set sail from Majorca with 22,000 men, the *élite* of his combined armies. A severe storm scattered the fleet on the 19th and caused great suffering to the troops overcrowded on the vessels, but a landing was effected on the 20th near Algiers. Before, however, the ammunition and provisions could be transferred on shore the tempest once more became so violent that fifteen men-of-war, over a hundred transports, and nearly 8000 seamen were cast away; while at the same time on land an immense *waterspout* burst over the camp, causing great sacrifice of life. The small quantity of powder which had reached shore in the men's bandoliers was spoilt by the rain and a large number of the troops were drowned, and the remainder, disheartened, defenceless, without food, and harassed by the Algerine horsemen, had scarcely sufficient strength to reach the fleet of Andrea Dorea but four leagues distant, sheltering behind Cape Métafuz. Nor were they more fortunate in their exodus than in their advent, for, when re-embarked, the tempest, still unsated with its prey, pursued the fleet so relentlessly that it was again dispersed; and it was only on December 3 that the Emperor arrived at Carthagena, storm-tossed and alone, each of the vessels fortunate enough to survive the passage having made a different port.

In Easter week 1586 the Earl of Leicester, then at the head of the allied forces in the Netherlands, pushed forward some Anglo-Dutch troops to the support of Grave, attacked by the Spaniards under Count Mansfeld. "Three thousand men," says the historian Motley, "on each side now met at push of pike on the bank of the Meuse. The rain was pouring in torrents, the wind was blowing a gale, the stream was rapidly rising and threatening to overwhelm its shores. The ground, slippery with rain and with blood, which was soon flowing almost as fast as the rain, afforded an unsteady footing to the combatants. They staggered like drunken men, fell upon their knees or upon their backs, and still, kneeling or rolling prostrate, maintained the deadly conflict. For the space of an hour and a half the fierce encounter of human passion outmastered the fury of the elements, but as the strength of the soldiers exhausted itself the violence of the tempest increased. The floods of rain and the blasts of the hurricane at last terminated the affray. The Spaniards, fairly conquered, were compelled to retire, lest the rapidly rising river should sweep away the frail and trembling bridge over which they had passed to their unsuccessful assault. The English and Netherlanders remained masters of the field. The rising flood too, which was fast converting meadows into a lake, was as useful to the conquerors (for defence) as it was damaging to the Spaniards."

Some present may remember Professor Gardiner's description of the dripping night before the battle of Dunbar,[1] in September 1650, and the moon bursting forth about 4 a.m.; the soaked and wearied men, the few look-outs excepted, cowering from the weather under the wet shocks of corn to snatch a few hours of uneasy sleep. As one of the officers was speeding past, his ear caught the voice of prayer sounding in the stillness of the night from the lips of a cornet, and halting to listen gathered fresh courage for the coming issue. For the army of Leslie lay between Cromwell's forces and England, in number nearly double! When a few hours later the Scottish forces were broken and soon their retreat became a rout, at that moment, as the sun arose out of the sea, Cromwell cried out, as his rough face lighted up with the joy of victory, "Let God arise, let His enemies be scattered." Nearly 3000 of Leslie's men perished on the field, and over 10,000 prisoners were taken and sent across the Atlantic.

The Duke of Monmouth's marches in the west of England in July 1685 were greatly impeded by the constant downpour, and his men, wading continuously through deep mud, became disheartened and many deserted.

In 1690 the first siege of Limerick failed owing to the extreme wetness of the season, and it was not until the following year that William the Third became master of that city. Similarly, Admiral Vernon's attack on Cartagena in South America (in 1741) was unsuccessful, owing to the very wet season (and the sluggishness of General Wentworth, who was in charge of the land forces). Out of 7000 men sent ashore, over half either died or were in hospital in a dying condition when the attempt was given up.[2]

The fall of Namur in 1692 was largely due to exceedingly heavy rains, which hindered the English forces from crossing the Mehaigne and giving battle to the investing French army.

The great rains throughout Spain in 1708 postponed the opening of the campaign there; and similarly in 1711 in the Netherlands both the hostile forces were paralysed by the same cause. In the spring of that year neither English nor French armies were able to manœuvre, while the roads were impracticable during prolonged rainfall.

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[1] Compare too the weather at Agincourt (in 1415): "After a night of heavy rain the morning of October 25 dawned bright and clear."

[2] A gruesome picture of this siege is given in Smollett's novel of *Roderick Random*.

In December 1745, after four days of steady rain, the retiring Highlanders (on their return from Derby) had great difficulty in fording the Esk, coming across with locked arms. Lower down the stream cavalry were stationed to pick up those who were carried away by the violence of the torrent and were in danger of being drowned.

In 1759 Wolfe's first attempt upon Quebec (at the crossing of the Montmorenci) failed, greatly owing to a very heavy blinding squall coming on in the midst of the assault.

The Prussians, during the retreat of the Duke of Brunswick's forces in 1792 to the Rhine, suffered greatly from the heavy autumn rains, and lost from dysentery and fevers more than a fourth of their numbers.

In 1793 the English were for a short time in possession of Toulon. The *Juno* frigate was sent from there to Malta for reinforcements. "On her return," says Professor Laughton, "she made the harbour about ten o'clock on the night of the 9th of January 1794. It was dark, with drizzling rain, and Sir Samuel Hood (the captain),[1] ignorant of the abrupt evacuation of Toulon by the British forces, stood in without any suspicion and let go his anchor in the inner port. A boat came off with directions for the *Juno* to go into another branch of the harbour for quarantine, but while the captain was endeavouring to find out from the (pretended) health officers where his cousin Lord Hood was, a gleam of moonlight revealed their tricoloured cockades, and finding themselves detected they admitted that the English admiral had been gone some time. At the same moment a flaw of wind swept over the harbour, and Hood, promptly taking advantage of it, cut the cable and made all sail. As soon as the ship gathered way the batteries opened fire upon her from the shore, but in the rain and darkness the ship got away with little damage." "An enterprise," says James in his *Naval History*, "more happily conceived or more ably executed has seldom been witnessed than that by which the officers and men of the *Juno* extricated their ship from the far interior of an enemy's port filled with armed vessels and flanked by land batteries of the most formidable description." Captain Hood's escape is the more wonderful as the ship for a short time touched the ground in the harbour.

The French troops advancing into the Biscayan Provinces in October 1794 routed the Spanish forces opposing them at Roncesvalles, capturing forty pieces of artillery. The Spanish infantry when retreating were saved, however, through a severe tempest of wind accompanied by very heavy rain springing up and checking the pursuit. It will be remembered that, in the winter of 1813-14, the English troops were also great sufferers from the weather at Roncesvalles.

In the campaign of 1796 in Italy, Napoleon was defeated at Caldiero by Alvinzi in November, after many hours' very stubborn fighting. The rain which fell in torrents during the battle, and the heavy mud which clogged their wheels, prevented the French guns from being brought into action, while the Austrian cannon, already in position, played with terrible effect upon Massena's close columns of attack.

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[1] Hood was a very gallant officer, and only three years before, while the *Juno* was lying in St. Anne's Harbour, Jamaica, succeeded during a violent storm, and at great personal risk, in bringing off three men from a wreck. The attempt was so hazardous that the boat's crew hung back at first; but the captain himself, saying, "I never in my life gave a sailor an order that I was not ready to execute myself," jumped in and shoved off to the wreck.

In the wet closing months of 1796 Moreau, in his retreat through the Black Forest, was on one occasion protected on his approach to the valley of the Rhine by a violent storm which interrupted the Austrian attack, and so allowed him an opportunity of retirement unmolested. During the same wet period the trenches of the Austrian investing forces at Kehl on the Rhine were flooded for weeks together.

One of the greatest misfortunes which has befallen the British arms occurred in 1807, whereby the English predominance in a great portion of South America was for ever forfeited. In 1806 a small British force had seized the opulent city of Buenos Ayres, but later on was driven out by the Spaniards. Accordingly an expedition was sent out in the following year under General Whitelocke, a most incompetent officer, who capitulated after a portion of his widely dispersed force only had been engaged. Even two of his much-divided columns met with success in their assault and entrance into the city. The attack was made prematurely on account of the impending rainy season, and so the weather was perhaps in some measure responsible for the loss to this country of so important a colony as the fertile lands around Buenos Ayres and Montevideo, and of an enormous extension of British influence across the seas.[1]

The roads in Poland in the winter of 1806-7, until set by the frost, resembled

> the great Serbonian bog
> Betwixt Damiata and Mount Casius old,
> Where armies whole have sunk,

so frightful was their condition—mud in places three feet deep, and a harsh winter alternately deluging the marching columns with drenching rain, driving pitiless sleet, or melted snow; soldiers on either side often up to the middle in morasses, bivouacking without shelter or buildings on cold, damp, sodden ground, or crossing icy streams swollen by melted snow.

Even as far south as Portugal an amusing picture is given in General Thiebault's memoirs of General Junot's men in 1807 on their way to Lisbon marching through a flooded district minus their clothes, which, however, were rolled up in their haversacks on their bare backs.

After the hard-fought battle of Heilsberg in Eastern Prussia in 1807, "heavy rain fell in the early part of the night, which, though it severely distressed the unhurt soldiers in their dripping bivouacks, assuaged the thirst and so diminished the suffering of the fevered host of wounded of both armies who lay mingled together on the blood-stained plain. The scene of action, a quarter of a mile broad and over a mile in length, presented, as the light slowly broke, a sheet of naked human bodies, the greater part dead, but some showing by their motions that they preserved consciousness or implored relief. Six thousand corpses were lying close together on the soaked ground, stripped during the night of every garment by the cupidity of the camp-followers of either army, ghastly white or empurpled with the blood slowly oozing from their wounds."

The state of the British army in Holland in 1809, as is well known, was deplorable. Owing to the long delay among the islands on the coast at the wettest time of the year, over 3000 men were struck down by malarial or "polder" fever at Walcheren; and owing to the inundations, some natural, some artificial, the British camping-grounds were under water. As in the case of the fever brought home by the troops from Corunna, the malarial poison remained in the blood and continued to affect many of the troops who fought later on in the Peninsula. A notable instance was that of General Sir Thomas Picton, who was still suffering from Walcheren fever in 1812.

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[1] In consequence of this defeat, an English force on its way out for the conquest of Chili was also recalled.

The Duke of Marlborough, it will be remembered, suffered constantly during his later campaigns in the Low Countries from the "polder fever."

In May 1809, during the perilous interval between the battles of Aspern and of Wagram, Napoleon's sole means of communication, the bridges across the Danube, were three times swept away by the rising of the river after heavy rains; while at Znaim, in July of the same year, a battle between the Archduke Charles and Marshal Massena was entirely suspended for some hours owing to a dreadful storm which darkened the air at noon and deluged both the contending armies with such torrents of rain that the discharge of fire-arms became impossible. These were the days before breech-loaders and magazine rifles.[1]

The capture of the Bridge of Ponte Nova during Soult's retreat from Portugal in May 1809 was a most daring act. A French major—Dulong—with four-and-twenty plucky grenadiers crawled over the bridge in the teeth of the enemy guarding it—at first unperceived owing to the darkness of the night, the roar of the swollen torrent below, and the pelting rain which drove the Portuguese sentries under cover. Once in possession of the bridge, reinforcements came over rapidly and the important link was secured unharmed.

The successful defence of Tarifa by General Sir Charles Smith was much aided by the weather. The French, however, made a desperate final effort on the last day of 1811, but bad weather and a continuous downpour of rain greatly damaged the French batteries and trenches, and supply became difficult owing to the condition of the roads. This led finally to the abandonment of the siege.

Colonel Napier[2] gives a dramatic picture of the English troops retiring from the Huebra in November 1812. The Duke of Wellington had prescribed a circuitous route on account of the heavy rain. The junior officers, far more competent to judge than the great leader himself, took a nearer and more direct one. "Meanwhile," says Napier, "Wellington, who had before daylight placed himself at an important point on his own route, waited impatiently for the arrival of the leading division until the dawn, then, suspecting something of what had happened, galloped to the other road and found the would-be commanders stopped by that flood which his arrangements had been made to avoid. The insubordination and danger to the whole army were alike glaring, yet the practical rebuke was so severe and so deeply felt that, with one proud, sarcastic observation indicating contempt more than anger, he led back the troops and drew off his forces safely."

One of the most striking illustrations of the effects of weather in war-time is perhaps that of the battle of the Katzbach in Silesia, which took place in August 1813, between the French and the army of General Blücher. I quote the words of Marshal the Duke of Tarentum, the commander of the defeated army:[1] "It had been steadily raining since the previous day. The ground was sodden, and the guns could only be moved with extreme difficulty. [To-day the field artillery is still heavier.] The rain still continued, and the men could not even use their muskets." A little farther in his account he says: "In the centre our guns sank in the mire up to their axles and could not be moved. It was getting late, the rain went on unceasingly, the ground was soaked, the ravines were filling and the streams were overflowing. The state of affairs was so disheartening that I ordered a retreat. A night march under such circumstances occasioned great disorder: the rain never stopped, the roads were flooded, and all the troops were marching in disarray and wet to the skin." The bridges over the Bober were carried away by the swollen torrent, adding to the difficulties of the position. It was this time Napoleon's turn to lose, in like weather, the legions of Varus.

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[1] At the battle of Telissu in June 1904 (in Manchuria), a blinding rainstorm came on and, blotting everything from view, ended the conflict—fortunately for the Russians, who were the losers.

[2] *Peninsular War*, book xix. chap. v.

It was a wet autumn, and a month later, in September 1813, a corps of two thousand Turks encamped on an island in the Danube near the fortress of Widdin were surprised by a sudden rise of the river after heavy rain, and not being able to get boats were all drowned.

The following year the state of the roads retarded the Duke of Wellington's advance into the South of France for quite two months (January and February 1814), when a slow approach was made towards Toulouse, with frequent halts brought about by swollen rivers and demolished bridges. On one occasion, at the beginning of April, General Picton's corps was in great jeopardy through the weather. When passing over the Garonne on the night of the 4th, a violent storm of wind and rain set in, causing the river to become so turbulent that the pontoon bridges had to be hastily dismantled in order to preserve them from being dashed to pieces, and the English force, in the presence of no less formidable an opponent than Marshal Soult, was thus, in consequence of the heavy rainfall, temporarily cut in two.

The rainy weather in the Waterloo week will not be forgotten either.[2] Hooper says of the morning of the battle: "The light of the sun was obscured by a thick mass of clouds. The woods were slowly dripping with wet. The heavy crops hung their heads with the moisture. The ground was plashy and yielding, and in the hollows in the valleys were wide pools. The air was filled with mist, and as far as the eye could penetrate it the country was gloom, silence, and dreariness. Between the two armies, save for the watchful sentries or vedettes, no signs of waking life were visible at daybreak." A writer on the French side speaks of the men being "glad to pull their shoes out of the deep mud in which they were buried at every step, and being chilled and drenched to the waists by the wet grain they forced their way through. Marching nearly all night, without rations, sleeping in water, and forbidden to light a fire." Sir Walter Scott's lines will also be remembered:—

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[1] From Mr. Simeon's translation of the Autobiography of Marshal Macdonald.

[2] When Wellington retired from Quatre Bras upon Waterloo his troops moved over the fields, leaving the road free for artillery and wagon trains. The pursuing French had scarcely reached Genappe when the heavy rain rendered the fields impassable, and infantry, artillery, cavalry, and wagons were all compelled to use the road. Consequently the English got too far ahead, with their easier formation, to be harassed by the enemy during their retirement, as would have been the case if the weather had been fine; and a serious loss was thus avoided.

> Tempest-clouds prolong'd the sway
> Of timeless darkness over day;
> Whirlwind, thunderclap, and shower
> Mark'd it a predestin'd hour.
> Broad and frequent through the night
> Flash'd the sheets of levin-light;
> Muskets, gleaming lightnings back,
> Show'd the dreary bivouac
>   Where the soldiers lay,
> Chill and stiff and drench'd with rain,
> Wishing dawn of morn again
>   Though death should come with day.

We will now pass on to the spring of 1824. Greece was fighting for her independence. Lord Byron, already enfeebled by his residence in the malarious swamps of Venice and Ravenna, and by other causes, was aiding the Greeks. Missolonghi, which he was engaged in fortifying, was a fever trap. The mud, said Count Gamba, was so deep in the gateway that even an unopposed enemy would have found entrance difficult. Byron's departure was hindered by heavy rains. One day, riding out with Peter Gamba, he was caught in the rain and returned by water, and was seized with a shivering fit on the way back, followed by acute fever. From this chill he never recovered, becoming rapidly weaker and delirious. Ten days later Byron passed away. His remains were brought to England, and lay in state for two days on the site of this building.[1]

Another instance of the evil effects of situation and rainfall was that of Cawnpore in 1857 when reoccupied by our troops. They were not adequately provided with shelter during the rainy season and on the banks of the Ganges. Then came cholera.

The advance upon Lucknow began on September 19, 1857; then the rain returned, and the column was brought to a halt early in the afternoon. It continued to rain all night and right through the following day; but on the 23rd the sun burst forth brilliantly, and the men suffered greatly from the intense heat, aggravated by the ponderous moisture.

When General Lee was bringing up the Confederate Army, in May 1863, to attack General Hooker's Northerners across the Rappahannock, rain set in so heavily and so continuously as to greatly delay his movements. Carts and guns stuck fast in the muddy ruts, and the teams had to be helped on by the plucky but almost exhausted infantry tugging at the ropes and harness. In consequence of this delay General Hooker just had time to get his men out of reach across the rapidly swelling river. So fast did the water rise that one of his three pontoon bridges had to be broken up in order to be employed to prolong the other two.

A few months later, General Lee's retirement from Pennsylvania, after the battle of Gettysburg in July 1863, was greatly hampered by similar weather. The country was so saturated by constant rain that any rapid movements off the hard main roads were impracticable.

Marshal Bazaine excused his inactivity at Metz on August 13, 1870, by reason of his additional trestle bridges across the Moselle being carried away by the flooding of that river after heavy rain, so that he could not transfer his army rapidly enough, by the few permanent bridges, from one side of the river to the other. At the battle of Woerth (on August 6) the roads were very heavy after rain, and the river Sauer was much swollen.

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[1] That of the Institution of Civil Engineers, Great George Street, Westminster.

Another feature, and difficulty, in war-time—the provision for the sick and wounded—is intensified by bad weather. Thus Sir Evelyn Wood, in his lately published *Autobiography*, mentions during the Ashanti Expedition of 1874 arriving at Ordasu: "Just as we had finished lifting the cots of the wounded off the ground an impending storm broke, the heavens opening, rain fell as it does only in the tropics, and within ten minutes there were ten inches of water on the ground."

"Alas for the poor wounded! Rain is a cruel torment to badly wounded men. Do I not still recall with a shudder" (says Sir Ian Hamilton) "the anguish of the biting cold and of the heavy raindrops falling—falling all night long—on my sun-blistered face, as I lay outstretched on the veldt beneath Majuba in 1881?"

During the war in South Africa the very heavy rain throughout the entire closing week of February 1900 was responsible (according to the German official account) for the delay of a week in the advance of the British forces. "The heavy rain which lasted since February 22 utterly spoilt the roads with their clay soil, although under ordinary circumstances these were quite tolerable. The Commander-in-Chief was therefore compelled to halt for a week, despite the advantage this gave to the Boers in concentrating their commandos."

On October 12, 1904, when the Japanese endeavoured to cut off General Stakelberg's retreat they started at 7 p.m. "The rain came down in a perfect deluge, and the night was dismal, stormy, and dark as Erebus. Slipping in the icy mud, covered up to their waists with layers of congealed clay, the gallant fellows stuck to their task until five o'clock the next morning, when they got within two hundred yards of the Russians.[1]"

HAIL.

When the forces of the five kings of the Amorites were put to flight by Joshua, more perished, we are told, from the great hailstones[2] than were put to the sword by the Israelites.

At Ascalon, in January 1191, Richard I.'s army experienced at first heavy rains, then heavy snow and hail.

In the spring of 1360, when Edward III., at the head of his army, was in France, he encountered, when in the vicinity of Chartres, one of the most dreadful storms recorded in history. The violence of the wind, the bulk of the hailstones, the incessant glare of the lightning, and the sight of hundreds slain around him greatly depressed the king. In a fit of remorse at this accompaniment of the war carried on for his own enhancement, he sprang from the saddle, and, stretching his arms towards the cathedral of Chartres, vowed to God and the Virgin that he would no longer object to proposals of peace, provided that they were compatible with his honour.

"I have often read with incredulity," says Sir Evelyn Wood,

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[1] Sir Ian Hamilton's *Staff Officer's Scrapbook*, vol. ii. p. 245.

[2] The hail which fell upon the Egyptians [Exodus] is still more remarkable on account of the climate and almost absence of rain in Egypt.

"travellers' stories of hailstones being as large as walnuts, and can scarcely therefore hope my readers will believe my statements when I say that I have seen many such in Natal under the Drakensberg Mountains." This was after describing a storm which occurred during the Zulu campaign of 1878.

SNOW.

The passage of the Alps by Hannibal is too well known to dilate upon. It was repeated later by the Emperor Majorian, in 457, marching at the head of his forces "on foot in complete armour, sounding with an alpenstock the depth of the snow."

When serving with Charles of Navarre at the close of 1378, Sir Thomas Trivet attempted to take by surprise the town of Soria in Northern Spain, but so heavy a snowstorm came on after the expedition started that the English forces lost their way and the attempt failed.

The winter of 1708-9 was a memorable one. The English army in Flanders went into winter quarters in December, and for three months endured great hardships. The campaign only terminated three days before a very deep snow fell blocking the roads. This was followed by a prolonged frost of nearly three months. On four occasions in that period the cold was intense and the sufferings of the troops, short of firewood during so protracted a period, very great.

During the memorable winter of 1709, which was most severely felt in Eastern Europe, the army of Charles XII. kept the field until Christmas. In one of the long marches in Russia it is said that two thousand men fell out of the ranks helpless and almost frozen to death. The intensity of the cold compelled, however, both King and Czar to agree to a temporary armistice during the month of January, but on February 1 the opposing forces resumed their military operations in the midst of frost and snow.

In January 1713 Marshal Steinbock, in retaliation for the enemy's burning of Stade, committed Altona to the flames. The conflagration, fanned by a piercing North wind, continued from midnight until ten the following morning—the houses were chiefly constructed of wood—and the next day only the ashes denoted that a town had once existed there. The inhabitants fled to the neighbouring hills, which were deep in snow, and the greater number of the women and children perished from the rigour of the season and from the inhumanity of the burghers of Hamburg, who denied them shelter.

We have a similar picture of horror nearer home. During the rebellion of 1715-16 the Earl of Mar, to delay the march of Argyll, burnt the villages, corn, and other forage on his line of advance in the east of Scotland, a destruction very cruelly felt in so severe a winter. This devastation was carried out during heavy snowstorms, biting winds, and keen frost, and the outcries of the women and children of the villages "drew tears even from the eyes of the barbarous Highlanders" who kindled the flames. Happily, nowadays, with improved means of communication and organised provision for forces in the field, the local supply is of comparatively small moment, and usually the necessity for laying waste a country is spared.

At the siege of Frederickshal in Norway, in November 1718, the soldiers were so benumbed with cold that they could scarcely turn up the earth, which was so much hardened by the frost that it was almost as difficult to dig as if they had been opening trenches in solid rock, and the tools even broke in the hands of the men. Several soldiers fell dead from the intense cold while on sentry duty, and most of the animals, needed for food, in the surrounding country perished.

Carlyle gives in his powerful crayon strokes a glimpse of Frederick the Great in the critical moments before the battle of Mollwitz, in the spring of 1741. "Sunday being a day of wild drifting snow so that you could not see twenty paces, there was nothing for it but to sit quiet. The King makes all his dispositions . . . these snowy six-and-thirty hours at Pogarell were probably, since the Cüstrin time, the most anxious of Frederick's life. Neipperg, for his part, struggles forward a few miles this Sunday, April 9 ; the Prussians rest under shelter in the wild weather. The Austrians are now fairly got between us and Ohlau, if, in the blowing drift, we know it—or they know it. But in this confusion of the elements neither party knows of the other. All this day, this Sunday, 9th, it still snows and blows—you cannot see a yard before you. Not the least news from any quarter. We are cut off from our magazines, have only provision for one other day. 'Had this weather lasted,' said an Austrian chronicle, 'His Majesty of Prussia would have passed his time very ill.' Indeed, the King had hardly slept for two nights, so great was his anxiety. Monday morning the Prussians are up betimes. All is calm, sleeked out into spotless white; Pogarell and the world are wrapt as in a winding-sheet, near two feet of snow on the ground." Then follows the description of the battle.

In 1745 Marshal Wade, the great predecessor of Metcalf and Telford, when pursuing the rebels in the north, marched to Hexham to intercept them—instead of which he was himself cut off and imprisoned there while the rebels captured Carlisle! On November 16 a snowstorm of almost unequalled severity and duration blockaded the troops at Hexham, and neither roads nor paths could be cleared for some days to permit of any military movement taking place.

The year 1771 was memorable for the exodus of the Kalmuck Tartars —or rather of that portion of them which left Russia to return to their original home in China. The march of such huge numbers over so great a distance was in itself a most trying one, but it was also made surrounded by enemies and during the severity of a Siberian winter. During the earlier weeks of this extraordinary exodus the most intense cold prevailed, much snow fell, and the loss of life, of men, women, and children, was very great independently of those slain by the Russians. The camels alone seemed inured both to short commons and to the inclemency of the climate. A not infrequent spectacle on the journey was a circle of Tartars, with their wives and children, gathered round the expiring embers of a central fire (for fuel, like other necessaries, had run short) all dead and stiff at the return of morning light. Many, too, dropped behind from sheer exhaustion, and were cut to pieces by the Cossacks.

When the Americans attempted to seize Quebec in 1775, General Montgomery, starting from Wolfe's Cove, attacked the lower town, and Benedict Arnold the upper town, simultaneously. Both assaults were made in a blinding snowstorm, and both signally failed, for the English garrison was on the alert. Montgomery was killed in the attack, and Arnold was wounded.

Napoleon's famous Passage of the Alps has been so often described that it is not necessary to recall it, but a characteristic trait of the early days of that marvellous man from the pages of Mons. de Bourrienne, his school-fellow, may be of interest. "During the winter of 1783-84, so memorable for heavy falls of snow, the cadets of the military college at Brienne used to pace up and down the Drill Hall for exercise. Napoleon, wearying of so monotonous a promenade, induced his comrades to amuse themselves with the snow in the large court-yard, and told them to get shovels and make horn works, dig trenches, raise parapets, cavaliers, etc. 'This done,' said he, 'we will divide ourselves into two groups, form a siege, and I will undertake to direct the attack.' The proposal was received with enthusiasm, and the mimic warfare carried on for more than a fortnight, and did not cease until the gravel and small stones became mixed with our snow cannon-balls, and many, both of besiegers and besieged, became seriously injured."

Undaunted was the courage of the Russian forces under Prince Souwarroff in October 1799 retiring, undismayed by defeat, into the Grisons, climbing the Alps near Glarus. The snow, soft and newly fallen, was two feet deep, making the ascent so fatiguing that the strongest men could cover but two or three miles in a day. Numbers perished of cold, or sank down into crevices, where, unable to extricate themselves, they were buried by drifting snow. On the south side of the pass the difficulties were even greater—here the snow, hardened by a freezing wind, was so slippery that the men could not keep their footing, and numbers were crushed by the beasts of burden rolling down upon them from the higher part, or by masses of snow, detached or broken by the incessant traffic, sweeping down in avalanches upon those in front. The men slept in darkness on the snow unwarmed by fire or food, but nothing overcame the unconquerable spirit of these Russians when led by Souwarroff.

Much the same in the following year (in November 1800) was the experience of the French troops under General Macdonald[1] when crossing the Splugen Pass. Guides placed poles in advance, labourers followed to cut a track in the snow, the most robust dragoons next followed to beat down the road with their horses' hoofs, and the men, after incredible fatigues, had nearly reached the summit when a tearing wind arose and loosened the snow above. An avalanche tore down the side of the mountain and the leading squadrons of cavalry were swept to instant death amongst the ice and rocks at the foot of the valley; and the high wind continued to rage so boisterously that for the three succeeding days the passage was blocked and no further progress could be made. Many of the soldiers and labourers died of the excessive cold and exposure.

In another part of the theatre of war the great battle of Hohenlinden was fought in December (1800) in nearly impossible weather for manœuvring. For many days steady and heavy rain had fallen. The night before the battle the wind went round to the North, and snow fell as at Eylau, in such thick flakes as to render it impossible to see many yards in front of the advancing columns.[1] Neither were they able to keep touch with each other, all the cross paths being impassable in such a storm.

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[1] Already referred to on p. 89, under his later title of Duke of Tarentum.

On Linden, when the sun was low,
All bloodless lay the untrodden snow,
And dark as winter was the flow
Of Iser, rolling rapidly.

The forces of the Archduke John, caught at disadvantage in the Forest, were driven, after a hard struggle, into headlong retreat by General Moreau with the loss of a hundred pieces of cannon.

The Duke of Wellington, conversing one day (in 1831) about the war in Spain, said the French had taken Pampeluna by stratagem. The garrison were playing at snowballs, and the French advanced under pretence of joining in their sport and then suddenly rushed into the fort.

The French army in the north of Spain underwent great privations in 1808. Moving forward to envelop Sir John Moore's force, the advance columns reached the foot of the Guadarrama Pass on the evening of December 22, but a violent hurricane of wind and snow was raging, and the thermometer on the mountain road was standing at 14° Fahr. The General in command of the advance guard, after twelve hours of fruitless toil, reported to headquarters that the passage was impracticable. The conqueror of the St. Bernard was not easily arrested, and Napoleon in person hastened to the advanced posts, and ordered the advance to be continued, himself setting an example by pressing forward with the leading files on foot. Thus animated afresh, amidst storms of snow and sleet, which on the higher slopes of the mountain were truly frightful, the columns pressed on with ceaseless activity, and after two days of exposure and incessant labour reached the other side of the mountains, and began descending into the valley of the Douro.

The condition of Sir John Moore's retiring army was even worse. The frost in Galicia had been succeeded by a thaw, rain and sleet fell in torrents, the roads were almost broken up, horses foundered at every step. The night the troops left Lugo was cold and tempestuous; a severe storm of wind and rain, mixed with sleet, burst upon the worn-out men, and in the confusion of darkness two divisions lost their way, and a complete disorganisation ensued.

"The long-drawn agony of the retreat of the Grand Army from Russia in 1812 is historic. On October 19 the eagles were carried out through the gates of Moscow. On November 6 the Russian winter set in with even more than ordinary severity. Up nearly to this time the weather had been singularly mild.[2] Cold fogs rose from the surface of the ground and obscured the heretofore unclouded sun, a few flakes of snow next began to float in the atmosphere, and filled the army with dread; gradually the light of day declined, and a thick murky darkness overspread the firmament. Wind rose, and soon blew with cutting violence, howling through the forests, or sweeping over the huge plains with resistless fury; the snow fell in thick and continued showers, fast deeply covering the earth with an impenetrable clothing, confounding all objects together, and leaving the army to wander, pathlessly, in the dark over an icy desert. Numbers of soldiers fell into ditches or holes concealed by the treacherous surface, and many perished before the eyes of their comrades. To fall was certain destruction; the severity of the tempest speedily checked respiration, and the snow, accumulating round the sufferer, soon formed a sepulchre for his remains. The succeeding columns found the surface broken by a multitude of these mounds. Accustomed as the soldiers were to death in its usual form, there was something appalling in the uniformity of the snowy wilderness, which, like a vast winding-sheet, seemed ready to envelop the remains of the whole army. Exhausted by fatigue and want of food, or pierced by cold, they sank by thousands on the road. Clouds of vultures issued from the forests and hovered over the dying bodies of the soldiers, while troops of dogs following the army, driven to fury by hunger, howled in the rear, and fell upon their victims even before life was extinct. The only objects which rose above the snow were the tall pines, whose gigantic stems and somewhat funereal foliage cast a gloom over the scene. . . . Amidst these horrors the wearied men sought in vain for the shelter even of a rock, the cover of some habitation, or the warmth of a fire, sank down to rest and never awoke."[1]

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[1] The snowstorm during the battle of Eylau in February 1807 was so thick that neither army could see its opponent, and in one of the Russian attacks the long lances of the Cossacks were nearly in contact with the French infantry before their onset was discovered.

[2] The Russians considered this almost summerlike weather a special mark of favour accorded by the Almighty to Napoleon (*Labaume*). It was, however, the cause of the fatal delay so disastrous to the French army later.

A spectator in Berlin gives a horrible picture of some of the survivors on reaching that city. "One of them had lost all his ten fingers, another wanted both ears and nose. Still more terrible was the appearance of a third, whose eyes had been frozen. The eyelids hung down rotting, the globes of the eyes were burst and protruding from their sockets. Another figure I could scarce believe to be a human being, so wild and distorted were the features. His lips were eaten away, and he grinned at us like a death's head; then burst out into wild laughter, and shouted out the word of command with a raucous voice, more like the bark of a dog than anything human, and we saw that the poor wretch was mad from frozen brain."[2] One of the contributing causes to the ruin of the cavalry, and to the abandonment of so large a part of the guns early in the retreat, was the absence of provision of tools for roughing the shoes of the horses.

Glimpses of the severe winter and snowfall in the opening months of 1814 are given in the vivid pages of Erckmann-Chatrian.

In the East a very successful campaign amid the snows was that of General Sir David Ochterlony in the spring of 1815, in Nepaul. At an elevation of 5000 feet above sea-level, and amidst constant snowfall at a most inclement season of the year, Sir David succeeded in bringing up men, elephants, and even guns, to attack the Gurkhas in the country around Simla. In the following year the hardships of the troops operating at so great an altitude were even greater, as they were for a time operating "without baggage or tents, through deep and rocky defiles, sombre and tangled forests, and by rugged and precipitous ascents," and at a very low temperature. The success of these campaigns in the mountains led finally to the winning over and enlistment of some of our finest native levies under the British flag.

Nor must one pass from India without mention of Colonel Kelly's march in 1895 over the mountains, to the relief of the hard-pressed English garrison at Chitral, at the head of Sikhs from the hottest plains of the Punjaub. It was a magnificent performance, the route being at times close on 12,000 feet above the level of the sea—the men often plunging up to the armpits in snow—many blinded by the sunglare on the white surface—and all nearly sleepless at night; and at a temperature of zero (Fahr.).

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[1] Sir Archibald Alison.

[2] Forster to Körner, January 14, 1813.

ICE.

Unlike snow, which impedes all movements of large bodies and hinders supplies, ice is frequently of assistance in warfare, as, with some occasional exceptions, I shall proceed to show.

One of the earliest instances is the escape of the Empress Matilda when besieged at Oxford in 1142. One night just before Christmas, when the garrison was hard pressed and provisions were running short, the Empress and three attendant knights, arrayed in white robes, succeeded in stealing across the ice-bound river unseen, and creeping silently over newly fallen snow, passed undiscovered through King Stephen's lines of investment and escaped to the fortress-castle at Wallingford.

When the Hungarians under Hunyades succeeded in getting over the Balkans, in December 1443, they had to overcome every kind of obstruction the Turks could employ to guard the passes. Here ice became an impediment. At one place in a very narrow defile between steep cliffs the Ottomans collected and poured the water of a mountain stream throughout the night down the steep slope of a gorge in the hills, which froze as it trickled down, and formed by the next day an impassable slanting wall of ice against the advancing Christians. At other places they loosened masses of snow on the higher mountains, starting them in avalanches downwards to crush the invaders toiling up the passes.

An attempt of the Swedish army to seize Ratisbon in January 1641, by taking advantage of the Danube being frozen over, was foiled by a sudden change of wind and thawing of the ice.

Two severe winters are indicated in the military operations of the Civil War in this country. The Scottish army under the Earl of Leven, which acted in conjunction with the Parliamentary forces in England, reached the Tweed in January 1644 in mid-winter. The ice covering the river was still so thick that on the 19th the entire army, waggons, and guns crossed over on it without delay or accident. The Earl (even better known as Leslie) was also in time to get his forces across the frozen Tyne, though on the next day—following the transit—a spate or flood, due to the snow melting in the Cheviots, rendered the stream impassable even by boat.

Eleven months later, when the Scots occupied Hereford in December 1645, the governor was fortunate in not being captured, making his escape by crossing the Wye, then thickly coated with ice, at dusk, unperceived by the enemy's patrols.

Perhaps, however, the most important military operation on ice was the invasion of Denmark in 1658.[1] The King of Sweden—Charles the

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[1] The Baltic was also frozen across in 1294, 1323, 1402, 1426, 1460, and 1548. The winters of modern days appear less severe. The crossing of the Russian troops from Finland to Sweden in 1809 was also over the ice of the Baltic, but in a less dangerous and exposed part.

Tenth—marched his entire army of men, horses, guns, munitions, and supplies across the Belts over the frozen surface of the Baltic to besiege Copenhagen.

In 1672 the French troops marching from Utrecht to Leyden over the ice were very nearly caught and cut off, owing to a sudden veering of the wind to the south and immediate thaw setting in.

The Duke of Marlborough wrote to Godolphin while investing Ghent in December 1708: "Till this frost yields we can neither break ground for our batteries nor open our trenches; and which is yet worse, if this weather continues all the canals will be frozen so that we shall not be able to get forage from Holland, the only place that can furnish us."

In November 1715, the morasses being frozen hard during the night enabled the cavalry to play an important part at the battle of Sheriffmuir.

In January 1716, when the Duke of Argyll was in pursuit of the Jacobite forces in Scotland he was delayed by cutting a way through the snow and clearing the roads. The Pretender, finding his situation becoming critical, evacuated Perth, sinking his artillery in the Tay, and, taking advantage of the river being frozen, marched all his troops across the ice by ten o'clock on the morning of the 31st. The Pretender and the Earl of Mar came over at noon, and made their way to Montrose, and thence to France.

General Washington, in his surprise of the Hessians at Trenton on Christmas Day 1776, encountered great obstacles from the keenness of the winter. "The weather was frightful. Intense cold had set in on December 20, and the Delaware from bank to bank was thick with frozen blocks which had already piled into an icy mass lower down the river where the stream was checked by the tides. Ewing was unable to bring his men across at Trenton Ferry. Cadwalader tried first above Bristol and then below, but he encountered a solid field of rough ice between the open water and the Jersey shore, and though by great exertions he landed part of his infantry, they were too late, and the event was decided without him. The Delaware ran high and strong—the cold was sharp to the point of torture—and a blinding tempest of sleet and hail was hurled across the channel on the fierce, bitter wind. Huge jagged clumps of ice were tinged with blood from the cut feet of the men whose shoes got torn."

The very severe winter of 1794-95, during which our troops under the Duke of York in Flanders suffered so greatly,[1] afforded a striking evidence of the value of ice in military operations. In a few weeks the French army under General Pichegru succeeded in overrunning Holland, and in capturing Amsterdam itself. Canals, rivers, inundations, on this occasion offered no barriers to progress, and no wet ditches guarded the fortresses. The Meuse was passable at any point. Neither, as in ordinary times, could the lines of the enemy's advance be calculated by the defenders beforehand, as they might have been when confined to the usual routes, bridges, or fords.

[1] This winter is memorable also as being that of the first campaign of the Duke of Wellington. The keen north wind blew for weeks in succession over an unbroken wilderness of snow and ice, with the thermometer at 15° and even 20° below the zero of Fahrenheit. Colonel Wellesley commanded the rear guard and experienced severities equalling, if not indeed exceeding, those of the temperature during the retreat from Moscow in 1812. See however, a remark of the Duke of Wellington when in Spain, quoted on page 113.

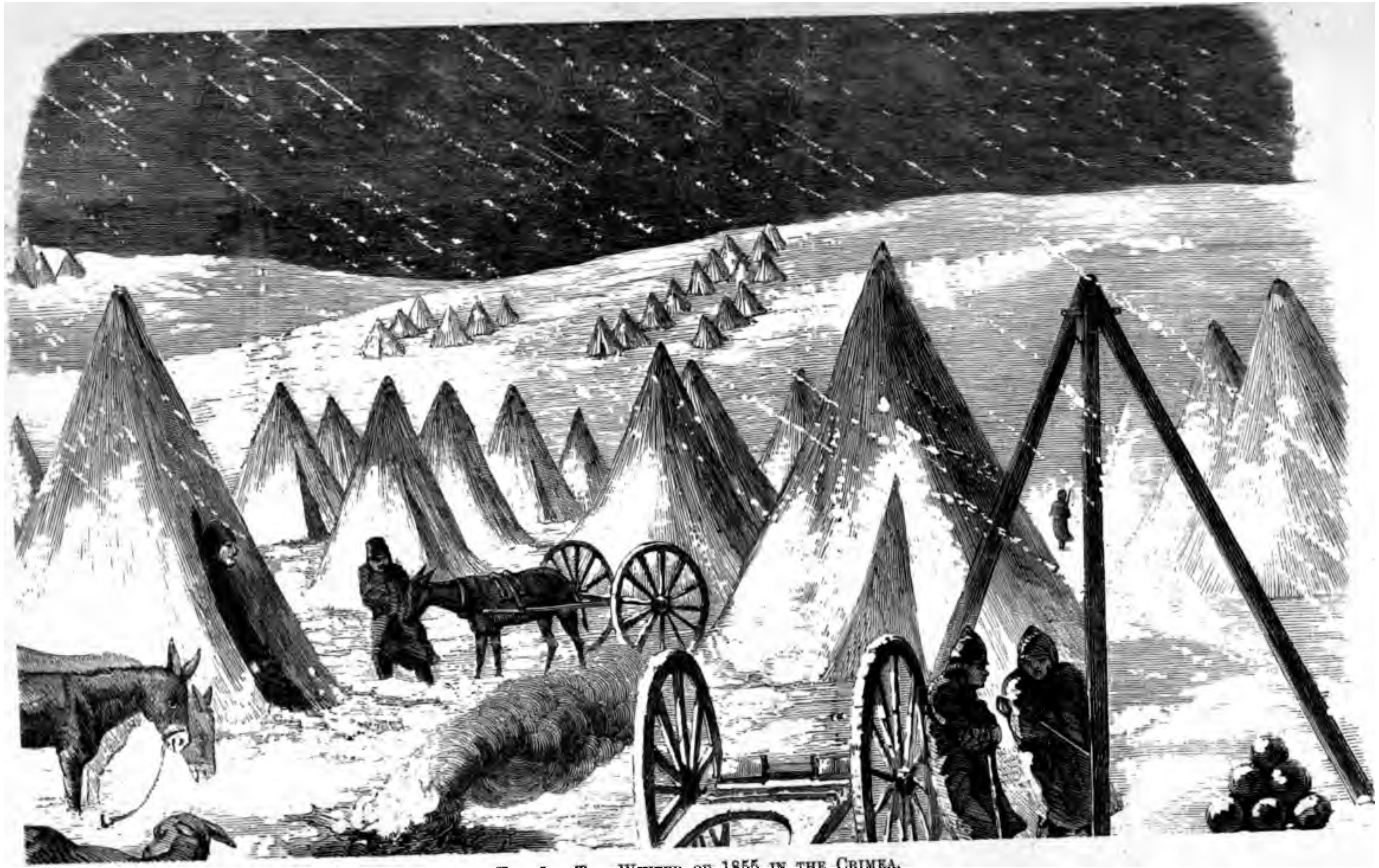

FIG. 1.—THE WINTER OF 1855 IN THE CRIMEA.

British Camp before Sebastopol.

It was the hardest winter for a century in Holland,[1] and a force of cavalry and flying artillery, after their horses had been roughed, even got across the salt water of the Zuyder Zee on the stout ice in January 1795, and summoned the Dutch fleet lying helplessly frozen up in the Texel. The commanders of the vessels were as astonished at the new form of warfare as they were helpless to resist it, and capitulated to the plucky French cavalry-men riding round the ships.

Another interesting use of ice was that by the Austrians to close the Tonal Pass in the Tyrol in 1800 against the advancing French. Three rows of fortifications were built of solid ice cut into regular square blocks, as if granite, but even more difficult to scale. The attacking force cut its way under fire through the abattis and palisades, when it found itself confronted by these massive walls, too treacherous to scale and too substantial to batter down, and in consequence was obliged to retire and report that the position was impregnable. A week later a second attack was delivered by General Vandamme; but in the interval still more ice forts had been constructed, and this assault also was repulsed.

No Frenchman will forget "the Sun of Austerlitz"! Of the great battle fought in December 1805 a far darker picture, however, exists—of more than twenty battalions of Russian troops under Generals Doctoroff and Langeron being overwhelmed as they retreated by the French Imperial Guard. Seven thousand were killed or taken prisoners. Great bodies of the fugitive Russians endeavoured to escape by crossing with their artillery and cavalry a frozen lake adjoining their line of march. The ice was already beginning to bend under the enormous weight, when shells from the French batteries bursting through the surface caused it instantly to crack with a loud rending explosion. A fearful yell of horror arose from the helpless perishing mass, and over 2000 brave men were engulfed in the surging waters. Lanfrey (a French writer) says that even on the day following the battle the cries and groans of some of the unfortunate men, supporting themselves on broken sheets of ice or on the piles of dead bodies of their comrades, could still be heard by the lake of. Telnitz. One is thankful to add that some exploration of the spot made not many years ago reduces the estimated extent of the loss on this tragic occasion.

In the early and severe winter of 1807 the ships of the English fleet then in the Great Belt were caught in the ice, and cut their way with much difficulty through to Hawke's Road (Wingo Sound), where they had to lie up for some months.

The terrible suffering at the passage of the Beresina[2] in 1812 is too well known and too painful to touch upon here.

It is curious that, in so southern a latitude, one of the difficulties the British had to contend with in their attack upon New Orleans in December 1814 arose from the exceeding cold from which the troops, and still more their black auxiliaries, suffered most severely. The

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[1] Some of the more historic frosts in Flanders of recent centuries were those of 1468, 1544, 1565, 1594, 1622, and 1658.

[2] The crossing took place at the same spot as that traversed by the army of Charles the Twelfth on its march upon Moscow in 1708. By the heroism of the French engineers—many working for hours, at peril of almost certain death, almost shoulder deep in the floating ice of the river—the pontoon bridges were with the utmost difficulty put together for the passage of the retiring army.

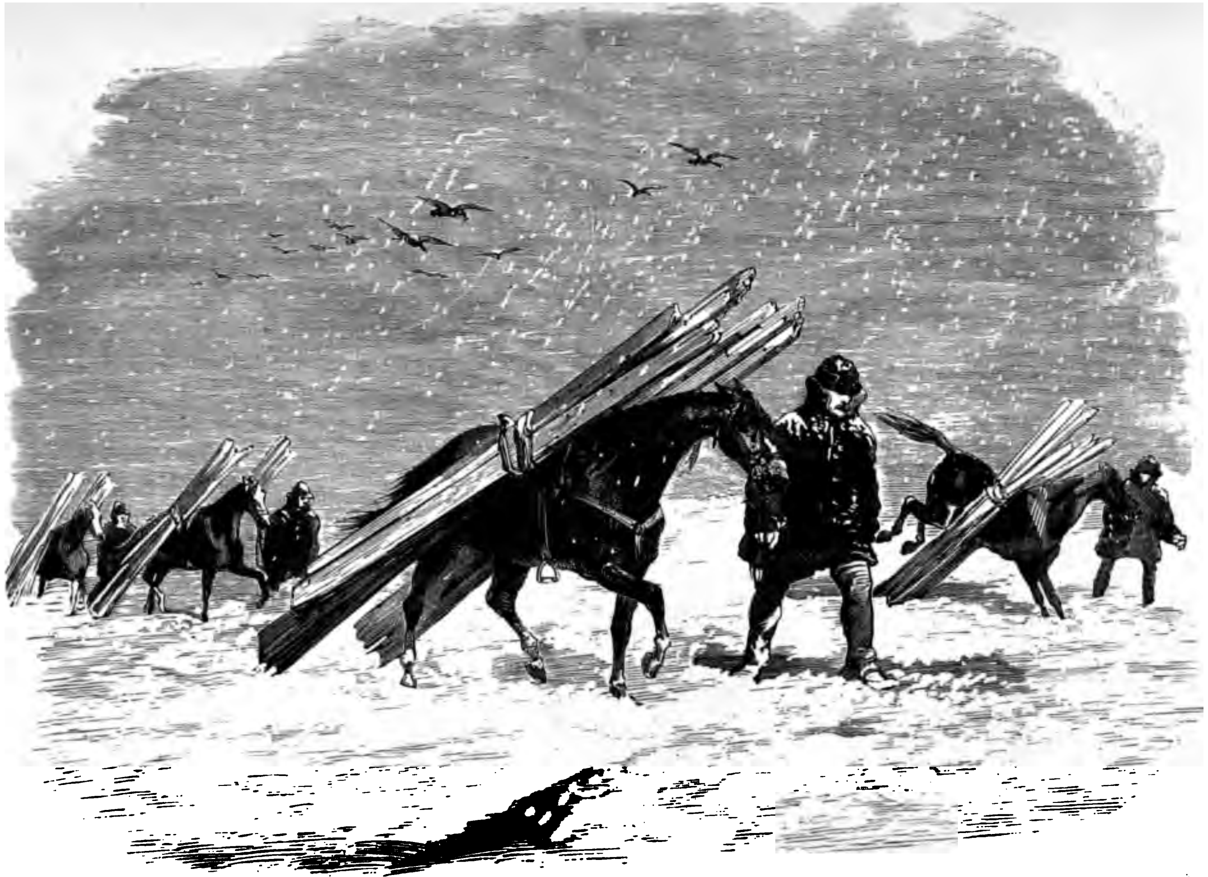

Fig. 2.—The Winter of 1855 in the Crimea.
Dragoons bringing up Materials to Camp from Balaclava.

landing of the troops and supplies was greatly delayed by the inclemency of the weather, one of the causes of our defeat.

Our difficulties during the Anglo-Russian War were twofold: the limitation of the season for naval operations in the Baltic; and the great severity of the winter of 1855 in the Crimea—the men without huts, badly fed, insufficiently clothed, and without firewood. The eating of half-raw food and the privations of weather[1] combined to bring on dysentery. The ground being great part of the time, too, alternately ice or mud, greatly hindered the bringing up of supplies from our base at Balaclava. When mentioning this winter we shall recall the famous Crimean cartoon of John Leech, "General Février turned Traitor."

The sufferings of the German forces invading France during the investment of Paris in 1870-71 were very severe owing to the north winds and frost, especially during the operations round Le Mans; but those of the newly-raised French levies, constantly on the march, were even still more felt; while the beleaguered population and garrison of Paris had the further disadvantage of having to subsist upon famine rations during the freezing weather.

On the night after the battle of the Peiwar Kotal, in the Afghan War of 1878, the English and native troops slept on the bare ground, even without cloaks, at an elevation of 9000 feet above sea-level, with the thermometer marking twenty degrees of frost, but without detriment from the exposure. In one of our latest military expeditions—that of 1900 in Thibet—the difficulties of the climate at high altitudes in the mountain passes were very successfully surmounted, even though once or twice the machine guns refused to act from the oil employed for lubrication becoming frozen.

During the recent Russo-Japanese War the temporary tramway on the ice at Lake Baikal and the blocking of the entrances to Vladivostock by floating ice will be remembered; while in naval warfare the effect of cold is also noticeable in another manner. When sea water is at a very low temperature the range of the torpedo is brief and sluggish, a circumstance which accounts for the large consumption of torpedoes in the recent operations round Port Arthur, a very large proportion of which were ineffective. Hence the attempt now being undertaken to charge modern torpedoes with hot air in addition to their explosive contents.

The cold in Manchuria in January 1905 "was intense. Horsemen galloped about the field," says Sir Ian Hamilton, "with the foam and dripping sweat of their horses changing into a crust like snow and long dangling icicles. The Fifth Division—only seventy yards distant from the Russians, near Heikoutai—had the choice between frost and fire. When they stamped their feet to keep life in them, the Russians, expecting an advance, fired on them. When the Japanese remained quiet they lost their toes. Four hundred of them were found to be suffering from *tosho* (frost-bite) the next morning."

The same narrator, when at Kinchou a few days previously, speaks of "writing in pencil, because my ink is frozen quite solid."

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[1] See also the gale in the Black Sea, on p. 135.

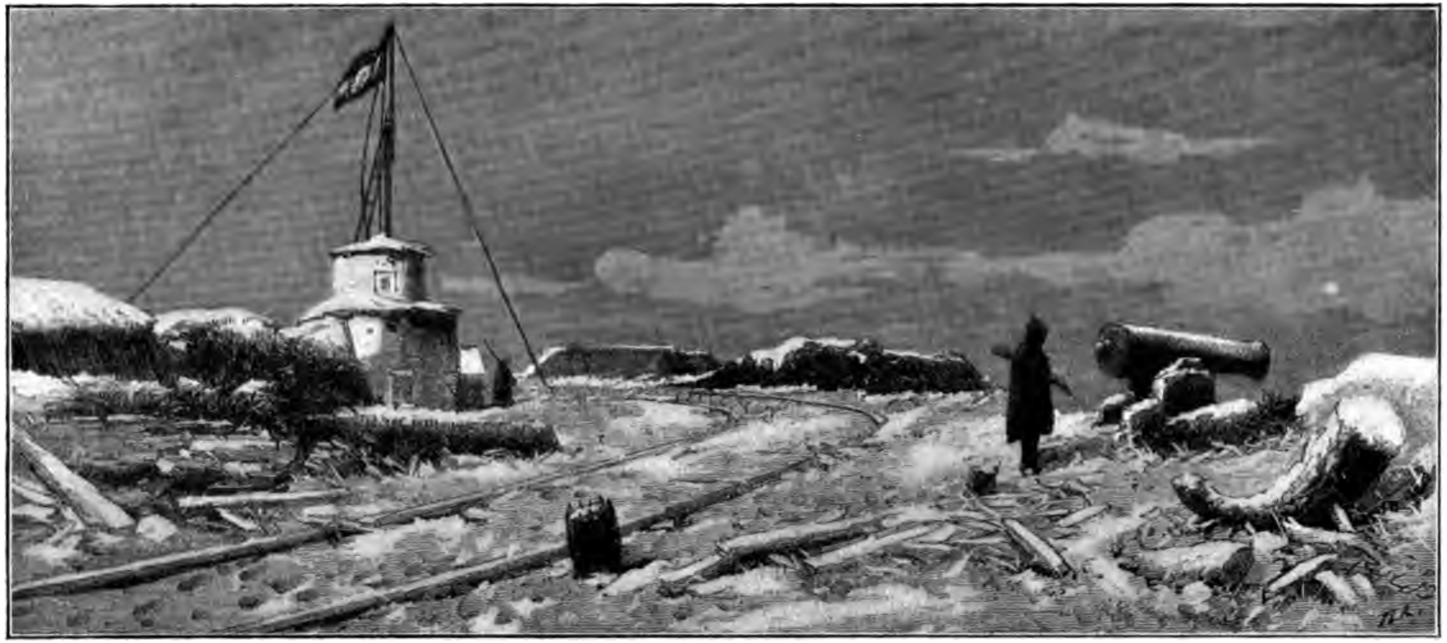

FIG. 3.—THE INVASION OF FRANCE.
Captured Fortress of Mont Valérien (Paris) in January 1871.

FOG.

Never are the chances of war more magnified than in fog.

The first exemplification which occurs is the battle of Barnet, between Edward the Fourth and the Earl of Warwick. At dawn on Easter Sunday, April 14, 1471, the two armies closed with each other in a fog so thick—the superstitious ascribed it to the incantations of Friar Bungay—that each side outflanked each other without being aware of it, and either force gained a victory on one of its wings. The centres, from whom the fortunes of the wings were hidden by the mist, fought desperately for three hours; but in the fog Warwick's men, mistaking Lord Oxford's cognisance of a silver star with streamers for "the Sun of York," made a vigorous onslaught on their own forces. This unexpected attack (entirely caused by the nature of the weather) turned the scale of victory in favour of King Edward, and Warwick was defeated and slain.

In 1565, during the heroic defence of Malta against the Turks, some reinforcements succeeded in making their way across the harbour to the beleaguered garrison. A thick fog lay upon the water, and under its friendly shelter the Spanish troops crossed over in safety to share with the gallant knights the perils of the protracted siege.

In 1571 the nearly impregnable castle of Dumbarton, situated on a rock which rises almost perpendicularly from a plain to the height of several hundred feet, was captured one misty night in April, the assailants climbing unnoticed up the face of the rock.

We all remember how Sir Philip Sidney, when mortally wounded, passed on a flask of water to another injured man, saying, "Thy necessity is yet greater than mine," but we may not recall the circumstance that his death was brought about by the state of the atmosphere.

On that eventful 22nd of September in 1586, an autumn mist—so thick that a man could not see farther than ten paces—covered the lowlands of Flanders. Sidney, with 200 horsemen, groped his way to the walls of Zutphen. Chivalrous punctilio caused him to be ill-defended, for meeting Sir William Pelham in light armour he threw off part of his own. The fog suddenly dispersed and the English found themselves under the guns of the town and confronted by nearly 1000 of the enemy's horse. They charged, and Sidney's horse was killed under him. He mounted another and joined in a second charge. Reinforcements galloped up and a third charge was made, during which Sidney received his death-wound; by some it is supposed the bullet was a poisoned one, for he lingered until October 7.

It was under somewhat similar circumstances that another hero met his death, at the first battle of Lutzen, in 1632. The morning opened thick with November fog. Gustavus Adolphus joined in the morning hymn sung by the Swedish troops, and then mounted his horse, putting aside his armour, which, owing to a former wound, was irksome. Towards noon the mist began to clear and the sun found its way through. The King, waving his sword over his head, cried, "Forward!" and led his troops to the attack. Wallenstein, however, bringing up all his reserves, succeeded in repelling the Swedish onslaught. The crisis of the battle had arrived, and Gustavus threw himself into the hottest part of it at the head of his cavalry. In ordinary life he knew when to temper daring with discretion—in the heat of battle he flung prudence to the winds. The troopers struggled in vain to keep up with the long strides of the King's fine charger. The fog came thickly down once more, and Gustavus, left almost alone in the dense mist, dashed unawares into a regiment of the enemy's cuirassiers. A shot passed through his horse's head, another shattered his left arm. While turning to ask for help from one of the few Guards remaining with him, yet a third shot struck the King in the back, and he fell heavily to the ground. A youth strove to raise him, but the wounded monarch was too heavy. The cuirassiers riding up asked who was there. "I *was* the King of Sweden," murmured the great warrior, and one of the horsemen shot him through the head and ended his pain.

A few years later, in 1645, Leslie,[1] Lord Newark, was hurriedly sent across the Border to arrest the progress of the victorious Montrose, and succeeded in surprising him in the early morning at Philiphaugh, near Selkirk. Montrose had injudiciously—for the time of year was September—encamped his forces on very low ground, probably to save the trouble of fetching water, and they were enveloped in thick mist when surprised, and almost annihilated, being unable to get into any formation in the fog. Montrose himself, with only a few horse, succeeded in escaping to the hills. The glory of Leslie's victory was, however, sullied by a wholesale massacre of camp-followers, both men and women.

The first attempt, as we all know, to release this country from the bigotry of James the Second was unsuccessful, and Monmouth was routed at Sedgemoor in 1685. The latest biographer of Marlborough says:—"The July night was still, but a heavy mist had risen after the recent rains, which, hanging over the low-lying moorlands round Chedzoy and Weston Zoyland, made it difficult for sentries or vedettes to see any distance. . . . When Monmouth's advance was discovered by a vedette of the Life Guards, shouts of alarm rose over the dreary waste of fog-covered moor, and all was confusion in the village and in the adjoining camp. Troopers, half asleep and still stupid from the previous night's debauch, mounted in hot haste, or rushed noisily about their billets in search of horse, arms, or breastplate. Though the full moon was still high the thick mist rendered it difficult to distinguish objects only a few yards distant. Saddles could not be found, bridles were missing, and turmoil and disorder reigned supreme. The surprise was complete; but an immediate attack boldly delivered and pushed home could alone convert it into victory, and Lord Grey was not the man to make it."[2]

Admiral Russell, Earl of Orford (whose political convictions have been as much discussed as the religious ones of the Vicar of Bray), crossed the Channel from Portsmouth in May 1692 and encountered the French fleet off Cape Barfleur. The battle was a severe one, but Shovel and Rooke broke through the French line, and the victory was practically gained, when the wind died down and a fog came up so thickly that all firing was stopped. At night when a slight breeze sprang up, the

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[1] The mention of Leslie in connection with fog recalls an anecdote. In the same year (1645) Sir Barnabas Scudamore defended Hereford against another Leslie (Earl of Leven). The siege was raised in September on the approach of Charles the First, and the gallant defender, also no mean courtier, remarked to his Majesty that "the Scottish Mist had melted away at the approach of the Sun."

[2] Lord Wolseley's *Life of Marlborough*, vol. i. p. 327.

French ships retreated in disorder to Brest, pursued, but not overtaken, by the slower ships of the English, who, however, came up with fifteen of the enemy's ships when delayed by currents off Alderney, and burnt them (see p. 127).

Fog, however, was more favourable to the English in 1705. The Baron de Pointis was lying with the enemy's fleet off Gibraltar, which Rooke had captured the year before. "Suddenly, without a note of warning from his signal stations on the Spanish coast, the head of a fleet loomed out of the blinding mist. It was Leake coming down on the dying gale, and Pointis knew he was doomed. He had scarcely time to cut his cables when the English vessels were upon him. One ship immediately struck, two were taken by boarding, two others were driven ashore and burnt. The rest were chased as far as Malaga on their retirement to Toulon. As Leake returned to Gibraltar a triumphant salute from the fortress proclaimed that the grip of England was set fast on the straits."[1]

Fog was the salvation of the valuable Levant merchant fleet in 1704. The French warships lay in wait for their intended prizes off the Bay of Tunis, and the richly-laden merchantmen from Scanderoon had no warning of the enemy's presence. By happy accident a dense fog came on in the nick of time and enveloped the Levant ships so completely that they passed almost within gunshot of the French vessels undetected.

The great Duke of Marlborough seldom neglected an opportunity, and succeeded in the dangerous operation of crossing a river like the Scheldt in the presence of an active enemy in 1708 by choosing his weather. The day the Duke's army crossed, a dense fog masked the preparations until the last moment, and the French were unprepared and unconscious of the movement until too late to arrest it.

The Swedes at Hango were more fortunate than the Baron de Pointis, in 1743, and their fleet succeeded in escaping in a heavy sea-fog from a similar descent upon it made by the Russian Count Lacy.

Lord Anson, after his cruise in the Pacific so destructive to the commerce of Spain, had the good fortune to get back safely to Spithead. In the interval of his absence we were at war with France. The French fleet happened to lie across his path up the English Channel, but during a dense sea-fog *The Centurion* passed unobserved through the middle of it, and reached Portsmouth on June 15, 1744. The treasure on board, at least £500,000, was sent up to London, and paraded in triumph through the city in a procession of thirty-two waggons, the ship's crew escorting it with colours flying and band playing.

Before the battle of Prestonpans in September 1745, "though the stars in the western sky were twinkling, a frosty mist rising on the lower lands by the coast covered the eastern horizon and rolled in white wreaths over the plain where the English troops lay on their arms; and the large fires kindled along the line of their encampment vaguely gleamed through the heavy fog which encircled them with a flickering and dubious halo."[2]

At the battle of Lowositz in Bohemia in October 1756, the fog early in the day was so thick as to have very serious consequences. Frederick the Great, being unable to reconnoitre the position, fell into the error of

[1] *England in the Mediterranean* (Corbett), vol. ii. p. 285.

[2] Sir W. Scott.

mistaking an Austrian force in front of him for the rear-guard merely of Marshal Browne, and sent his cavalry forward impetuously and unsupported to attack the whole of the Austrian army, and was nearly defeated in consequence.

It was after a long apprenticeship to war in the Russian army that Field-Marshal Keith took service under Frederick the Great during the Seven Years' War, and had share in so many victories. In October 1758 he met his death at Hochkirch. The Prussian army was posted in a dangerous situation, but the King would not make any change. About five o'clock on a very misty autumn morning, the right wing—a weak one—of the Prussian army was suddenly attacked (as Keith had previously warned Frederick it might be liable to surprise, so bad was its position) by the Austrians in overwhelming force, and shattered. Three times the heroic marshal essayed to retrieve the day, charging into the fog at the head of such troops as could be collected, and twice was he wounded, the second time mortally. When the battle was over, his nearly naked corpse, wrapped only in a Croat's mantle, was found by the son of a friend and so identified, and a military funeral with full honours was accorded to him by his great opponent Marshal Daun.[1]

The fog had helped the Austrians on this occasion, but was not always on the side of the assailants. Washington's attack on Lord Cornwallis at Germantown in 1777 was made under great difficulty, the weather being extremely hazy.

The battle of Valmy[2] in 1792 is another illustration of an engagement begun in fog. Professor Creasy says: "A thick autumnal mist floated in waves of vapour over the plains and ravines which lay between the contending forces, leaving only the tops of the hills gilded by the early light. About ten o'clock the fog began to clear, and the French on the heights of Valmy saw, emerging from white wreaths of mist, and sparkling in the sunshine, the countless Prussian cavalry and massive columns of infantry about to envelop them."

Lord Howe's victory on "the glorious first of June" (1794) was postponed for a couple of days by fog. Captain Hunter (one time Governor of New South Wales) was present in this battle, and, ten years later, had himself a remarkable experience in fog. He was then in command of the *Venerable*, 74, and as the fleet was getting under weigh in Torbay on the evening of November 24, 1804, to resume the blockade of Brest, a dense sea-fog suddenly came on. The ships were in no especial formation and soon lost all knowledge of each other's whereabouts. Twice the *Venerable* was obliged to bear up to avoid collision, and soon afterwards she went ashore under the red cliffs of Paignton. Another 74-gun ship, hearing her guns of distress, dropped anchor close by, and with difficulty and some loss took off the officers and crew. At daybreak no trace of the *Venerable* remained as the fog cleared away. From the evidence at the court-martial it was only by astonishing good fortune that many of the other ships of the squadron escaped her fate. It is somewhat singular that during a dense fog a sea should have got up sufficiently heavy to totally destroy so large a vessel, and that in partially protected waters.

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[1] Keith's statue may be seen both in Berlin and at Peterhead.

[2] The German poet Goethe was present at this battle, and has left his impressions of it on record.

General Jourdan was surprised near Würzburg on the Main in September 1796 by the Archduke Charles, who took advantage of a very thick fog to concentrate in superior force at the point chosen for attack, and so completely defeat his opponent. In the same month General Marceau succeeded in making a sudden retreat before the superior forces of the Austrians undetected, owing to the density of the fog completely veiling his position and movements.

It was an anxious moment for the Spanish Admiral Don Josef de Cordoba when the white fog blew off about eleven o'clock on the morning of February 14, 1797, and the British fleet under Sir John Jervis, afterwards Earl St. Vincent, was found with ports raised already bearing down to the attack, the result of which was so disastrous to the fortunes of Spain.[1]

In the autumn of 1799 the Austrians[2] succeeded in getting into the outworks of Mannheim in a dense fog almost before the French were aware of their approach, and captured the town with heavy loss to the defenders, both of men and guns. Somewhat in the same manner in Egypt the French under General Menou attempted to surprise the troops under Sir Ralph Abercromby (in 1801) before the night mist had cleared off at Aboukir, but the result was different.

Great was the astonishment of the Prussian outposts when, in the grey mist of the early morning at Jéna in October 1806, they found the French battalions closing in upon and advancing swiftly in the finest order to the attack. For two wearisome hours had Suchet's division shivered in its ranks in the cold night fog impatiently waiting the order to move on. Under cover of the dense mist the French troops got through the defiles, and at nine o'clock, when the increasing power of the sun dispersed the fog, the Prussians perceived the magnitude of the danger by which they were threatened. But it was too late then to avert the catastrophe!

At the bloody battle of Auerstadt fought on the same day thirteen miles to the north of Jéna, a dense mist similarly concealed the opening movements of the French troops and led the King of Prussia to underrate the forces in front of him.

In 1808 the almost impregnable Somosierra Pass, in Spain, was captured by Napoleon with a few squadrons only of the Polish cavalry of the Imperial Guard. Emerging quite abruptly from the mountain mist, still thicker with the smoke of the guns, by their sudden appearance at close quarters they threw the Spanish force into an instantaneous and wild panic, during which the key of the position was seized.

In the same year the French fleet which was blockaded at Rochefort succeeded in slipping out to sea unperceived in a heavy sea-fog. (Nowadays nature itself is imitated, and in an attack on a fortified harbour very often use is made of artificial fog (or smoke) to conceal the movements of torpedo boats or other craft.)

When Napoleon closed the ports of Europe to British trade, amongst other useful depots for blockade-running, the island of Anhalt in the Baltic was seized by us in 1809. In March 1811 a determined attempt to

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[1] The second battle of St. Vincent.

[2] They also defeated General Lecourbe in the following year near Salzburg in a thick fog.

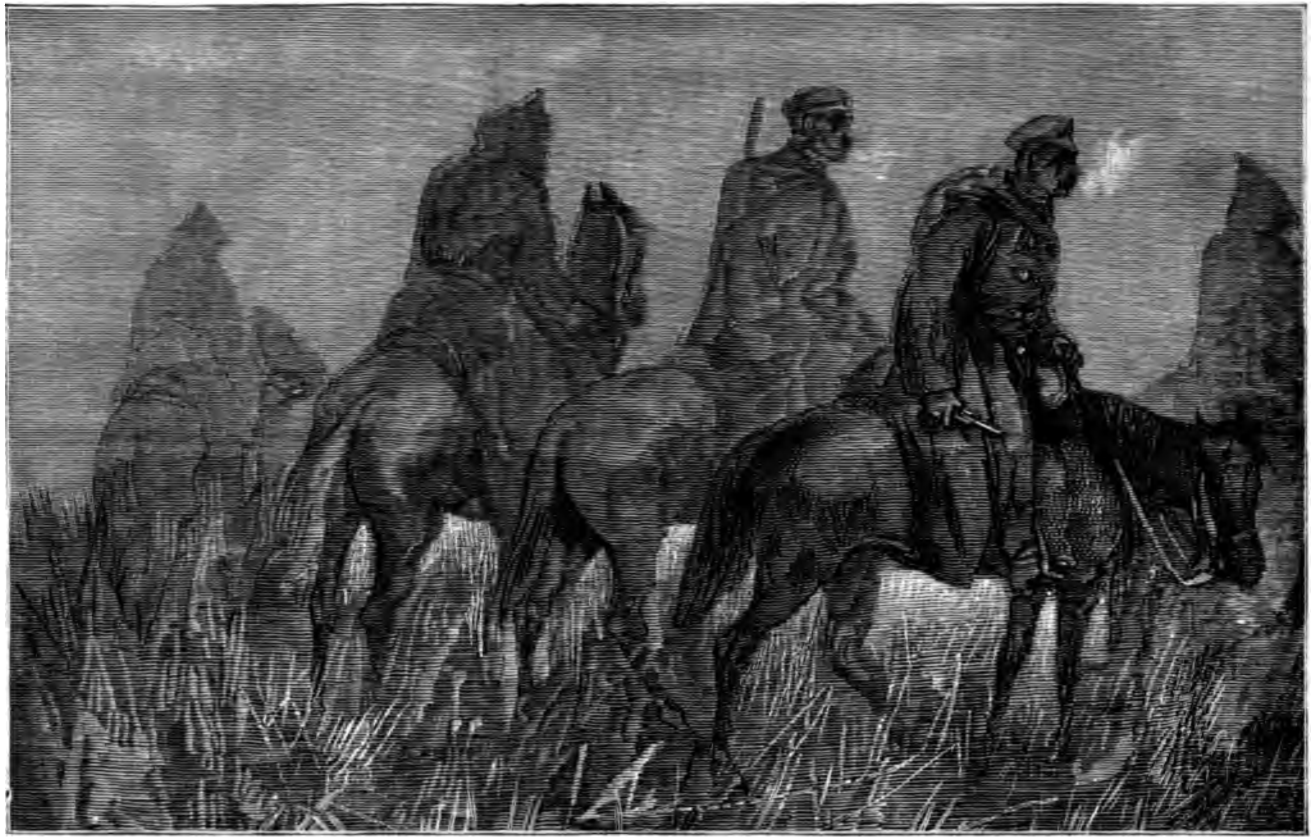

FIG. 4. WAR OF 1877 IN TURKEY.
Russian Cavalry Outposts in a Fog near Plevna.

recover it was made by the Danes, and one very dark foggy night twelve gunboats with accompanying transports succeeded in landing a thousand men on the island and made a resolute attack on the slenderly garrisoned fort. It so happened, however, that owing to the thickness of the atmosphere the Danes were unaware of the approach also of two English men-of-war to the island, who suddenly in turn opened an attack upon them. The intending surprisers were themselves surprised, and thus taken between two fires the tables were turned, and the Danes scattered, pursued, and made prisoners. The fog on Anhalt was long remembered.

It was owing to a combination of fog and rain that the English attack at Sabugal (in the Peninsular War) in April 1811 was made prematurely and on the wrong point, which brought the assailing force perilously near a disaster.

The fog on the morning of the assault of San Sebastian (in August 1813) delayed one of the most desperate and bloody struggles in the long war; and in the same year the dense mist on December 13 enabled Marshal Soult to prepare one of his most dangerous strokes unperceived—his sudden attack on Lord Hill's force at St. Pierre when separated from the rest of the British army, previous rains having carried away the bridge of communication across the Nive.[1]

In the South American War of Independence, Lord Cochrane's first attack on the fortified harbour of Callao, in February 1819, was under cover of a thick fog.

In the Anglo-Russian War we have[2] the attack upon Inkermann in November 1854[3] made during fog, when the advance of the enemy was detected by ear; and General Mouravieff s bloody but unsuccessful attempt to escalade Kars in September 1855 under cover of the morning mist, lasting nearly seven hours, and repelled so gallantly by General Teesdale and the Turkish garrison.

General Grant's attack on the Confederates in the battle of the Wilderness was made on May 12, 1864. "Dense fog favoured the approach of the stormers in the early morning. General Hancock's Northerners rushed the breastwork and captured nearly the whole of the second Confederate corps, about three thousand men. . . . The struggle at the next line of defence was, however, a desperate one. . . . Rain fell heavily, and a steaming mist rose mingled with the smoke of battle, and almost concealed the masses of men locked in deadly embrace. The rain increased in force towards the evening, but fighting went on until the murky darkness made it impossible to distinguish friend from foe."[4]

The turning movement of the Crown Prince of Prussia at Sedan in 1870 was largely assisted, it will be remembered, by fog during the passage of his forces across the Meuse in the early morning.

Sir Ian Hamilton[5] gives a graceful pen-sketch (in 1904) of a scene in the last war: "Half revealed by the illusive radiance of the moon, the commonest objects assumed fantastic shapes in sympathy with my thoughts about the morrow. Near the foot of the Motienling we ourselves were strangely transfigured into a procession of phantoms groping through billows of clinging white mist which poured down the slope in ever thicker and clammier volumes. At last, at 5 a.m., we topped the pass, and found ourselves uplifted over the shifting, mysterious veil which now filled the whole of the great valley from which we had climbed. The sun was just rising, very angry and red, and his light struck full against the sharp pinnacles which stood up from the mist like great emeralds floating in a milky sea. To the westwards the foggy vapours were already rolling away their curtain from the scene of the approaching world-drama, of which we alone were to be the tiny group of privileged spectators. But why did the actors lag? Was it to enable us to admire the marvellous beauty of the setting of the play? Here beneath us were some eighty thousand men within shooting distance of one another. . . . At 6.45 a.m. the battle began."

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[1] A panic on the Stock Exchange in 1812, caused by a semaphore telegram from the seat of war in Spain being interrupted and altered by a fog during its transmission, has already been mentioned, vol. xxxii. p. 97.

[2] Besides the grounding and loss of H.M.S. *Tiger* at Odessa in a fog.

[3] One of the most graphic accounts of this hard-fought battle is that given at the time by one present, the narrative of Mr. Woods in the columns of the *Morning Chronicle*.

[4] Captain Battine.

[5] *A Staff Officer's Scrap Book.*

The battle of Tsushima in 1905 is still freshly in our memories, when Admiral Rozhdestvensky's fleet was annihilated by the Japanese warships under Admiral Togo bursting forth from the mist in the Sea of Japan. Says Captain Semenoff:—

> The night came on dark. The mist seemed to grow denser, and through it but few stars could be seen. On the dark deck there prevailed a strained stillness, broken at times only by the sighs of the sleepers, the steps of an officer, or by an order given in an undertone. Near the guns the motionless figures of their crews seemed like dead, but all were wide awake, gazing keenly into the darkness.

THUNDER.

One of the earliest military incidents connected with thunderstorms is probably the death in 87 B.C. of the Roman general Pompeius Strabo, when commanding an army operating in the vicinity of Rome against Cinna. He was struck dead by a flash of lightning—the less regretted as, though an able general, he was, according to Cicero, hated for his cruelty and avarice.

The origin of the so-called "Thundering Legion" is familiar to readers of Gibbon, and has been referred to on a previous occasion.

The postponement of the battle of Crecy until the afternoon on account of the torrents of rain, thunder, and lightning, is described by many writers.

When Donald Balloch, the general of the last Lord of the Isles, made his great raid into Atholl in 1462, and carried off the Earl and Countess from the castle of Blair, he also desecrated the chapel of St. Bridget. On his way back to Islay with his prisoners a terrible storm of thunder and lightning burst over his galleys, several of which, being heavily laden with spoil, foundered. This visitation so impressed Balloch that, besides at once returning to do penance at the plundered and partially burnt chapel, he also released the Earl and Countess of Atholl from their dungeon.

Sir James Lancaster, one of the sea captains of Queen Elizabeth and a forerunner of the great East India Company, was notorious for the bad weather he encountered. On one of his expeditions round the Cape against the Portuguese he lost most of his crew, only twenty-five returning to England out of 198 men. Many of those lost were killed by lightning in a violent storm in the Indian Ocean.

During the Civil War, at the battle of Marston Moor in July 1644, "just as the armies were joining battle and beginning the first encounter of each other, it pleased the Lord that a sudden and mighty great storm of rain and hail and terrible claps of thunder were heard and seen from the clouds, as if Heaven had resolved to second the assault with a fierce alarum from above."[1]

Marshal Massena's last effort to break out during his heroic defence of Genoa in 1800 was in the direction of Monte Creto. As the French columns of attack approached the Austrian lines a very violent thunderstorm enveloped the mountain, darkening the air, and the rain descended in torrents. The atmosphere became so sombre that at last the hostile forces could only discern their position by the vivid flashes of lightning which constantly lit up the gloom. At the very height of the tempest the opposing forces met, and the first line of entrenchments was carried by the advancing French, but the Austrian reserves coming up succeeded in repelling any further attack, and General Soult, who was severely wounded, was made prisoner. This check sealed the fate of Genoa.

In Germany, during Marshal Davoût's advance upon Abensberg in April 1809, a severe engagement took place with the troops of the Archduke Charles at Thaun. A thunderstorm of such exceeding violence swept across the field of battle in the evening that it separated the combatants, after each had sustained a loss of 3000 men, without either being able to boast of any decisive advantage.

A historic storm was that connected with the invasion of Russia by Napoleon. The sultry heat of the weather as the troops crossed the Niemen (in June 1812) was succeeded by a tempest the fury of which resembled the devastating hurricanes of tropical climates. Upon the multitudes of the French, who had just traversed the sterile plains or inhospitable forests of Poland, its violence fell with unmitigated severity. Horses perished by hundreds from the heavy work entailed by the incessant rain and from the soaked provender. No less than 10,000 dead carcases, one writer states, were lying by the roadsides around Wilna alone, and 120 pieces of cannon and 500 munition-wagons were left behind. In less than a week 25,000 sick troops were admitted to the hospitals, and General Dumas describes how the westerly wind carried with it a gruesome pestilential smell from the long line of unburied men and horses left behind the army on its march eastward.

Many will recall Napier's vivid description of the evening in July 1812 which preceded the battle of Salamanca, after the trying dog-day heat following a previously exceedingly cold June: "Night came suddenly down with more than common darkness, for a storm—the common precursor of a battle in the Peninsula—was at hand. Torrents of rain deepened each moment the ford, the water foamed and dashed with ever increasing violence, the thunder was frequent and deafening, and the lightning swept in sheets of fire close over the column, or played on the points of the bayonets. One flash falling amongst the Fifth Dragoon Guards killed many men and horses, while hundreds of frightened animals breaking loose from their picquet-ropes and galloping panic-stricken were taken for the enemy's cavalry charging down in the darkness. . . . To a military eye there was nothing more imposing than the close and beautiful order in which the soldiers of the Light Division were seen by the fiery gleams to pursue their march amidst this astounding turmoil, defying alike the storm and the enemy."[1]

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[1] Vicars's narrative.

When Napoleon in 1813 retired behind the Elbe, and virtually restored Germany to freedom, his retreat was accompanied by a thunderstorm more remarkable from its occurrence at such a season. "C'était un phénomène," General Odelben says, "bien extraordinaire dans un pareil saison, et avec le froid qu'on venait d'éprouver," etc.

Marshal Ney's onslaught at Quatre Bras in June 1815 was accompanied by a furious storm which, though gathering all the forenoon, commenced at the very moment he made his attack about 2 p.m. on the British rear-guard. The first gun fired was instantly responded to by a tremendous peal of thunder overhead.

The Ninety-First Highlanders going out to Africa for the Kaffir War were shipwrecked in Table Bay in August 1842. During the hurricane one of the most terrible storms, even in that region, of thunder and lightning occurred. Owing to the splendid discipline of the men (for which they were subsequently greatly commended by the Duke of Wellington), not a life was lost. The men drew lots for the order in which they were to be rescued.

Lord Wolseley describes, during the Burmese War in 1853, a storm as the expedition was starting. "All ranks were extremely crowded and uncomfortable, which made us," he says, "feel the more keenly the great thunderstorm that overtook us on the evening of our departure from Rangoon. I had never seen its like before! Our anchors dragged in the soft mud of the Irrawaddy, and we were nearly driven ashore on the right bank. So vivid was the lightning that at each flash we could see the individual leaves of the jungle trees as they bent to the water's edge before the tornado. The heaviest tropical rain followed, and, when it stopped, an invasion of the largest and most muscular mosquitoes I have ever encountered, rendering all chance of sleep impossible."

The same writer also describes a storm in the other hemisphere during the expedition against Riel in Canada in 1870: "We experienced many heavy thunderstorms while encamped at Prince Arthur's landing. There is much hematite iron in this neighbourhood, and I wondered if its presence exercised a magnetic attraction over the electricity with which the heavens in that region seemed to be especially charged. But during the night of July 15, when encamped at Shebandowan, we had a thunderstorm to which all the others were merely boys' crackers compared with the firing of a monster gun. While it lasted the heavens seemed at times to open and let fall great crushing weights of explosives upon the earth beneath, which seemed to tremble at the shock. Then followed a rain the like of which I have never seen even in the tropics. It fell upon us not in drops, but literally as sheets of water in rapid succession. It suddenly began to fall, and ended as abruptly."

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[1] Yet so trying were the sudden changes of climate in Spain that the Duke says: "I never suffered more from cold than during the manœuvres of the days preceding the battle of Salamanca. You have no idea what the cold was, though it was the end of June" (Stanhope's *Conversations with the Duke of Wellington*).

[NOTE.—For explosions and fires on shipboard caused by lightning, and injury to powder magazines, see Sir William Snow Harris's *List of* 220 *Cases of Ships struck and damaged by Lightning*, the *Report of the Lightning Rod Conference*, and the *Quarterly Journal of the Royal Meteorological Society.*]

HEAT.

The hosts of Cambyses met a terrible fate in the hot sands of Libya, nearly 40,000 men[1] perishing in awful simooms.

Owing to the intensity of the heat the Emperor Julian, during his engagement with the Persians, put aside his cuirass. While he was pursuing the flying foe an arrow pierced him through the middle and mortally wounded him, at the early age of 32.

From the same cause, the Norwegian invaders, defeated by Harold at the battle of Stamford Bridge in 1066, were only partially armed. Not expecting the swift march of the English king, they had left their cuirasses on board their ships in the Humber, on account of the autumn heat, and so they fought at a disadvantage.

The advance of the Great Captain, Gonsalvo de Cordova, to the battle-field of Cerignola in 1503 was made with much difficulty on account of the extreme and sultry heat, even though it was only at the end of April. The troops, notwithstanding orders, had failed to supply themselves with sufficient supply of water on crossing the river (Ofanto). Parched with heat and dust, they were soon distressed by excessive thirst; and as the burning rays of the noontide sun beat fiercely on their heads many, especially those in heavy armour, sank down on the road, faint with exhaustion and fatigue. Gonsalvo moved from troop to troop endeavouring to reanimate his men, and commanded that each trooper should take one of the infantry on his crupper—making it a bad day for the horses.

La Valette, the undaunted Grand Master of the Knights, died at Malta from a sunstroke—happily received after his great mission was accomplished.

So great was the heat of the day at the battle of Mechlines in 1578 that, impatient of the sun's rays, to the astonishment both of friends and enemies, the Scottish auxiliaries flung off their upper garments and fought like furies in their shirts only. Indeed some doubt arises about any garments being worn, for in the plan of the battle given in Strada's *History of the War in Belgium*, printed in 1650, is a spot marked, "Here the Scots fought naked."[2]

At the battle of the Boyne in 1690 the heat of the day was very exhausting, and the English Cavalry were so fatigued after the battle—which was a long one—that they could not pursue far.

The sufferings from heat of the French army under General Kléber when in the Egyptian desert in 1798 are historic. "Even Lannes and Murat threw themselves on the sand and gave way to despair. In the midst of the general depression a sudden hope illuminated the countenances of the soldiers: a lake appeared in the arid wilderness, with villages and palm trees reflected in its glassy surface. The parched troops hurried towards the enchanting object, but it receded from their steps; in vain they pressed on with burning impatience, it fled again at their approach, and the fevered troops had the mortification of discovering that they had been deceived only by the mirage of the desert."

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[1] Professor Ernst Curtius puts the number at 50,000.

[2] Compare the Highlanders, in June 1689, stripping themselves to their shirts at the battle of Killiecrankie.

The following year, on their return to Egypt from the siege of St. Jean d'Acre, the retiring army underwent great privations in May on the march over the desert to El Arish. The temperature was 92°, but that of the sand walked upon was 113°. The water met with in the desert was so salt that numbers of horses dropped dead soon after drinking it; and, notwithstanding their previous experiences of the illusion, such was the deceitful appearance of the mirages constantly presenting themselves that the men were frequently rushing in search of cooling streams and glassy lakes which at their approach cruelly dissolved into air.[1]

In the operations which led to the capture of Washington in the autumn of 1814, after the defeat of the United States troops at Bladensberg, hardly any pursuit was attempted by the British. The extraordinary heat of the day had so exhausted both officers and men that for a couple of hours they lay down quite spent, and only resumed their advance on the capital when the fierceness of the day had been somewhat abated by the approach of evening.

One of the severest trials in warfare is exposure to heat, when either necessarily in the open, or when confined to carriages on the railway, or in tents. One's thoughts turn especially to India.

General Sir Thomas Seaton gives in his *Reminiscences* a vivid picture of the sufferings of a convoy he was with on its journey across the Shikapur desert in Baluchistan to Bagh during the intense heat of June 1839.

Four years later, and not far from the same spot, General Sir Charles Napier experienced great difficulties from the same cause. He had barely 5000 men with him, and in front was Shere Mohammed, "the Lion of Mirpur," with 26,000 troops. Napier was deficient in transport, and the thermometer stood at 110° in the shade. Sir Charles, however, attacked, defeated the enemy, and despite the overpowering heat pursued him for days by forced marches. All through the hot weather he succeeded in keeping the troops on his track. Before the conquest of Scinde was completed, large numbers of men had succumbed to climate, and Sir Charles, who never spared himself, was also prostrated by heat-stroke.

Knowing this, Lord Dalhousie in 1848 wished to delay the operations of the Second Sikh War until the hottest season of the year was past in a locality "where the fierceness of the heat," he said in his despatch, "is reputed to exceed that of any other district." The Commander-in-Chief, Lord Gough, also concurred, stating that "a fearful loss of life among British troops" would be the consequence of any premature movement; but the siege of Mooltan had already begun, and the movement of troops had to be continued in the hot season.

In the Burmese War of 1853 the heat in the hospital (double) tents in the confined air rose sometimes as high as 130° in the shade and was constantly over 100° at Prome.

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[1] Another very remarkable instance of a mirage in war-time is described in *Forty-one Years in India*, vol. i. p. 393.

The hot weather during the war of 1856-7 in the Persian Gulf was very harassing to our forces.

How terribly trying movements in heat are can be judged by the following. In 1857, during the Indian Mutiny, General Neill experienced the greatest difficulty in reaching Allahabad in time to save it. He was nearly captured by the rebels on his way from Benares, and when he reached Allahabad it was in the blazing heat of the Indian mid-day sun, and he and his scanty escort waded through burning sand for over a mile on the river bank before finding a boat. Two of his men sank down and died as they reached the boat. Neill was a man of great courage and energy, and despite the terrific heat within a few days recaptured the bridge over the Ganges previously seized by the mutineers, and secured the safety of what the Governor-General, Lord Canning, described as "the point most precious in India at this moment—and for many years the one most neglected!"

Another undertaking despite of temperature was that of General Seaton (already referred to) at Kankar in Oudh in April 1858. On this occasion he and his men marched out and back forty-four miles, defeated the enemy, taking his guns, stores, and other baggage, and returned without a single straggler, and all within twenty-three hours, although during a time of intense heat.

Sir Hugh Rose, afterwards Field-Marshal Lord Strathnairn, during the operations in Central India attacked the rebels at Kunch in May 1858. The thermometer was 110° in the shade and the engagement lasted until evening, our troops suffering as much from sunstroke as from the enemy's fire. Sir Hugh, while directing operations, was compelled to dismount no less than four times from exhaustion and excessive debility, and it was only after medical treatment that he was enabled to hold out until the day was won, while a large number of officers were either killed or prostrated by the intensity of the heat. Though the same troops had only recently been moving for seventeen days and nights with barely intervals for sleep during very great heat, on this occasion they were so exhausted as to be quite unable to take up the pursuit of the enemy after the capture of the place.

A fortnight later General Rose defeated the rebels again at Calpee, under very trying circumstances. "The fight was won," says Colonel Vetch, "by a force exhausted by hard marching, weakened by sickness, in a burning sun, with a suffocating hot wind, over an enemy ten times as numerous, and who attacked with a resolution and knowledge of tactics not previously displayed by the rebels."

The following month witnessed too Lord Strathnairn's triumphant recapture of Gwalior, achieved only after many harassing marches over great distances and in most trying heat.

Lord Wolseley, in the first volume of his *Autobiography*, says that "the horrors of a hot season under canvas on the baked fields of Oudh were terrible to the soldier in a crowded tent with nothing to do all day but fan the flies from his face as he lay on a rough native *charpoy*[1]—a weary existence indeed. We had no books for the men, and very few newspapers. Their life was horrible, and well might any man wish he was in a clean, cool English prison instead. If you knew the miseries our men endured uncomplainingly in the hot weather of 1858 in Oudh you would feel how much you ought to esteem every old soldier you meet who wears the Lucknow clasp." A few pages farther Lord Wolseley continues: "On one occasion in May 1858 our column moved off at 3 p.m. A fiercely hot wind blew upon me clouds of burning dust which scorched my skin, and I had to use heel and spur to make my Arab charger face it. Two miles from camp I came across a picket of the Seventh Hussars whose appearance was appalling. Two of its three officers lay helpless under trees with wet towels round their heads, and the men, in an exhausted condition, lay in twos and threes under whatever shelter they could find. I had a good helmet with an unusually long turban wound round it, and yet the sun seemed to gimlet a hole through into my brain. My very hair crackled from the burning heat, and one's finger-nails became brittle. Before we were fairly started, the division lost heavily in men disabled by heat-apoplexy, of which many subsequently died. During the march, men stifled from want of air and by the dense dust they inhaled fell out by dozens, while the enemy's cavalry, sweeping round our flanks, fell upon the *dhoolies*[1] filled with soldiers in every phase of sunstroke. The rebels killed many, decapitating them as they lay unconscious."

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[1] Native bedstead.

The Navy had very "hot work," at least in one sense, when our cruisers and gunboats patrolled the East Coast of Africa to seize the native *dhows* running with cargoes of slaves.

The heat at Zula, during the Abyssinian Expedition of 1868, says Lord Roberts in his *Forty-one Years' in India*, was intense, "117° in the daytime in my tent. Arrangements were accordingly made for the regiments to be embarked directly they arrived from the front, a matter of the utmost importance both on account of the fearful heat at Zula and of the scanty water supply."

At Kandahar, in August 1880, the conditions were nearly as taxing owing to the great diurnal variation of the thermometer: 105° in the tents during the day, but the nights were bitterly cold, and the sudden changes of temperature were extremely trying to any in bad health.

Coming to Africa, we find Sir Evelyn Wood testifying to the great heat in the valley of the Nile during the expedition of 1885. From 3 a.m. to 6 a.m. it was, he says, generally cool—for the Sudan—but from 10 a.m. to 4 p.m. daily (unless there happened to be a dust-storm to add to our discomfort) there was, as a rule, not a breath of air, and even lizards and flies clustered beneath the camel saddles to avoid the all-powerful sun.

In February 1900, during the war in South Africa, the heat was severely felt by the troops in Natal on the banks of the Tugela. On some days—despite the extreme peril Sir George White was in at Ladysmith—nothing was done on account of the heat, and difficulties were found in supplying the troops with water. Several attacks were also suspended because of the heat at the moment of success.[2]

In the Orange Free State the English force, though suffering no less from the intensity of the heat, but inspired by the indomitable energy of the Commander-in-Chief, pressed forward on foot for thirty-four toilsome miles in the day.

[1] Litters.

[2] German Staff Account, vol. ii. pp. 232-233, 237, and 242 of the translation.

During the battle of Yoshirei (in Manchuria) in 1904, Colonel Hume relates that a pause took place at 10.30 a.m., and he noticed a curious palpitating tremor, across the valley, which seemed to pulsate up and down the Japanese firing line. On looking more closely he found that each of the little fellows who composed it had pulled out his fan and was using it vigorously. "It certainly was an appalling hot day."

One phase of sunlight has been pressed into the service of war by the ancients as far back as the time of Alexander, viz. the flashing of intelligence by the use of mirrors at a distance. An improved instrument known as the heliograph was brought out by Mr. H. Mance of the Persian Telegraphs in 1875, and was used in fine weather in several of the more recent Indian campaigns, and during the Zulu War. For still greater distances we have now another aid, which is nearly weather-proof, viz. the wireless telegraphy, which transmits signals in the teeth of both wind and rain, and is not hindered by fog. The only susceptibility it has shown has been to very brilliant sunshine.

DROUGHT.

The effects of drought in war-time are very far-reaching, especially in earlier days, when the area from which supplies were drawn was a limited one, and no preserved or canned stores were available.

One of the earlier illustrations of a drought was in 1267 in Eastern England. Edward the First's attack by a naval force from the Wash upon the rebels in the Isle of Ely had been unsuccessful. Their position was exceedingly strong, guarded by fens, morasses, and boggy marshes on every side, and in ordinary weather would have proved impregnable to any force unacquainted with the few approaches or inlets. This particular summer happened, however, to be one of exceeding dryness, and Edward the First took advantage of it to construct causeways of wattles and hurdles over the swamps until he was able to come to close quarters with the rebel force, which was then glad to make terms with him. The King wisely granted favourable ones.

During the invasion of Holland by Louis the Fourteenth, the summer of 1672 was an excessively dry one. For some time the Prince of Orange contrived to guard the line of the Rhine; but the Prince de Condé was informed of the increasing shallowness of the river, and in particular of some shoals which were in one of the bends. The spot, having been sounded, was found to be fordable, and the French troops were hurried across to the number of 15,000, though for a few paces in the centre of the river the infantry had to be assisted through the current by cavalry on each side of them. This exploit created a great impression at the time, as the river had been looked upon as too difficult for troops to cross except by bridge.[1]

The summer of 1695 in Flanders was a very dry one, and the Maes nearly ran dry in shoal places. Owing to the low state of water in the river William III. was unable to bring up the vessels with stores, ammunition, and food from Liege and Maestricht, and the cargoes had to be brought overland to supply the army investing Namur.

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[1] In September 1745 the Pretender was equally fortunate, and succeeded in getting his men across the ford of Frew, over the Forth, some eight miles above Stirling, owing to the great drought which prevailed in Scotland during the latter part of the summer of that year. (On a previous occasion the Earl of Mar with a force of sturdy Highlanders had been unable to get across at the same spot.)

A curious result of the parching effects of a rainless summer may be referred to in 1811. The Portuguese troops were celebrating a success by a feu-de-joie near Badajos, when a corn-field ignited, being dried and withered by the continuous hot weather. The conflagration, fanned by a light South-westerly breeze, speedily took hold, and was past stamping out. It spread over the adjacent country with such astonishing rapidity that in three days it reached Merida, a distance of over thirty miles. That town only escaped total destruction by the fortunate circumstances of the breeze dropping, and the broad stream of the Guadiana, intervening between the town and the burning fields, checking the flames.

EARTHQUAKES.

Earthquakes during military operations are so accidental that only on few occasions have they exercised any appreciable effect on them.

One is related by Livy as having taken place during the battle of Trasimene, B.C. 217 (which was fought in a dense marsh-fog rising from the shores of the lake). According to both Livy and Pliny, the ardour of the combatants was so great that few of them took notice of the tremors of the ground. Some are noted also by Thucydides, who states that two expeditions of the Lacedæmonians were put a stop to by earthquakes, viz. in 426 B.C. and in 414 B.C.

Lucas—in his *History of the British Colonies*[1]—avers that the great earthquake which overwhelmed Port Royal in Jamaica in 1692 was one of the main reasons of the French expedition setting out in 1694 for the conquest of that island; but it is difficult to see the connection.

During the struggle for Greek Independence, Yussuf Pasha arrived with the Turkish troops before Patras on Palm Sunday, April 15, 1821. His approach was heralded by a very smart earthquake. Later in the day the town underwent a second shaking, this time being bombarded by the Turks, whereupon the Greeks took to flight.

When Sir Robert Sale, on his retirement from Cabul, was besieged by the Afghan army in 1842 at Jellalabad, the defences of that town were in ruins, and Captains Abbott and Broadfoot were entrusted with the task of their reconstruction, which was achieved with much labour. Towards the end of February, after three months' incessant toil, the fortifications were almost complete, when on the 19th an awful and mysterious sound was heard underfoot, the earth shook, the houses of the town trembled and fell, the ramparts of the fort tottered and came down with a crash, and in a few moments the position was rendered untenable and defenceless. "No time," says Captain Broadfoot, "was lost. The shocks had scarcely ceased when the entire garrison was told off into working parties, and before night the breaches were scarped, the rubbish below cleared away, and the ditches before them dug out, whilst the great one on the Peshawur side was protected by a temporary parapet of gabions. . . . Such was the energy and perseverance of the troops, that by the end of the month the parapets were rebuilt, or the curtains filled in where restoration was found impracticable, and every battery re-established." Mild shocks continued during March, but fortunately comparatively little damage was done by them.[1]

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[1] Vol. ii. p. 106.

Artificial tremors of the earth were reported by several persons in Kent—pellets of earth trickling down loose, newly dug earth—at the same time that the battle of Waterloo was being fought; and some of the vibrations from the bombardment of Alexandria in 1882 were traceable at Malta.

CALMS.

In days before the era of steam, calms were little short of calamitous, whether in sea-borne trade or in maritime warfare. The radius of action of the galleys and triremes was very limited, and the use of the "sweeps" could not be continuous or applied to the larger vessels.

Thus it was a long wait Lord Salisbury[2] had in 1378, when becalmed with his fleet in Plymouth Sound during June and under orders to sail for the relief of Hennebon and Brest.

In 1617 Sir Walter Raleigh's little squadron was becalmed for forty days in the Doldrums and ran short of water. The crews, a prey to scurvy and fever, were also on the brink of mutiny. They even refused to look out for the Spanish Plate Fleet from Mexico!

During Sir George Rooke's victorious attack on the fleet of M. de Château-Renault at Vigo in 1702, Admiral Hopson led the advance in his flagship *The Torbay*. The French fleet was protected by a boom laid across the harbour. *The Torbay* burst through the barrier successfully, but before any of the supporting ships behind could come up the breeze quite suddenly dropped, and Admiral Hopson alone was left anchored within the boom and encircled by the enemy's line-of-battle ships. For a time, while the calm lasted, his situation was in the highest degree critical, but Hopson held his own with dogged courage, until most fortunately, the breeze reviving, his consorts were able to come up and relieve the attack concentrated on *The Torbay*.

In 1801 the frigate *Success*, while engaged in watching at a distance the movements of a French fleet in the Mediterranean, became becalmed, and, after three days' manœuvring and attempting every expedient to escape, was cut off and captured.

A few years later Sir Arthur Wellesley, when under orders to go out to North America, was delayed by absence of wind for some weeks at Portsmouth, and before the breeze sprang up received instructions to be in readiness to proceed to the Peninsula instead.

CONTRARY WINDS.

As bad as calms were—before the days of steam—contrary winds. Several of our monarchs were great sufferers from these.

Henry the Second was very unfortunate in his weather when crossing to and from the Continent on his military expeditions. In March 1170 he was much tempest-tossed in the Channel, and again in July 1174 was buffeted in a gale. On his last voyage, to repel the invasion of Aquitaine, in July 1189, he was caught in a severe storm. On his arrival in France, too, a terrible thunderstorm burst over the royal party, which was viewed as a bad omen.

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[1] Captain Johnson, then a prisoner in the hands of the Afghans, gives a most alarming account of this earthquake in his diary, as being "the most fearful within the memory of any man in this country." See Kaye's *War in Afghanistan*, vol. ii. p. 491.

[2] The second Earl. He was as much at home on land—he fought at Poitiers—as on sea.

Few, however, suffered as much as Richard the First from unfavourable weather. In 1190 on his way to the Crusades he was storm-bound in Sicily. The following year his fleet was driven into Rhodes by a storm. The year after, his ship was driven ashore after six weeks' contrary winds and gales in the Adriatic (and he had once come within sight of Marseilles), and in rashly attempting to cross Germany he was made prisoner. In 1194, on Richard's return to England, he was detained by contrary winds at Cadzand. (His journey home was even more difficult than that of Charles the Twelfth from Turkey to Stralsund, crossing Europe through rain, wind, and snow, in the winter of 1714.)

Edward the Third was also an especial victim of the elements. On his return from the war in Flanders in 1340 (?) his passage home was a most tempestuous one. In 1341 his fleet intended to take part in the invasion of Scotland was greatly damaged at sea. When returning to England in 1343, after ravaging Brittany, his ship was so buffeted by head-winds that it was five weeks before the King reached Weymouth. His return home after the taking of Calais was equally stormy. In 1355 the King was unable to cross over to Cherbourg to take part in an impending war in France, owing to adverse winds throughout July.[1] In 1356 the English fleet was again unable through weather reasons to take part in the Scottish War. The fleet fitted out for the succour of Aquitaine was also blown back into harbour in the Channel in 1372.

After being over two hundred years an English possession, the skill of the Duke of Guise prevailed over British unreadiness, and in January 1558 Calais once more fell into the hands of the French. Ample warning of its danger had reached the Court in London, reinforcements even had been prepared under the Earl of Rutland, and were waiting in readiness on the shores of Kent—the winds kept rough and adverse, and none got across from Dover in time.

Sir Francis Drake was detained by contrary winds a whole month at Plymouth[2] when setting out on his expedition to Lisbon in 1589. On his return voyage he met with persistent bad weather and a violent storm off the Azores.

Ostend was so stoutly defended by Sir Francis Vere and his brother against the Spaniards that it held out for three years. On one occasion (in December 1601) during the first of these eventful years, the garrison had run out of supplies, when fortunately the wind fell and five ships managed to get into the harbour, under a heavy fire from the enemy's batteries, from Zeeland.

Gibraltar too passed through many anxious moments when the wind was in the wrong quarter for reinforcements.

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[1] A fleet of thirty-eight large vessels, with the King's two sons and three Earls, set sail on this occasion from Rotherhithe, but owing to head-winds only succeeded in getting as far as Greenwich.

[2] He was well disciplined after his fifty-two stormy days when beating round the Horn in 1578.

By the rudeness of the wind King Charles's Standard, when first unfurled at Nottingham in August 1642, was blown down repeatedly, an omen at the outset of the Civil War noted by Clarendon. So also in the rising of 1715 the Pretender's banner, on being raised on Deeside, was flouted by the rough wind, and its gilded top torn off.

Unfavourable winds proved great hindrances to blockading fleets. In 1650 when Prince Rupert was driven into the Tagus, a strong and continuous East wind prevented Admiral Popham from going in to attack his ships.

Many times were the watching vessels blown off the Breton coast during the blockades of Brest, first established by Hawke. On one occasion *The Ramillies*, 74, was blown back until she struck on the rocks under Bolt Head and was totally wrecked, with a loss of over 700 lives, in February 1760. Two years later Falconer published his poem of "The Shipwreck." He had served in Hawke's fleet (and by some accounts was one of the very few saved from *The Ramillies*). In the next war with France, for many years the Channel fleet lay buffeting with the Westerly winds off Brest[1] or was blown into Torbay temporarily for shelter.

Another frequent struggle with contrary winds arose during the protracted blockade of Toulon. On one occasion Nelson's observing ships were blown off their station, and his own vessel, *The Vanguard*, dismasted; during which time Bonaparte's expedition to Malta and Egypt sailed, with an army on board.

How often was not the great Marlborough detained at Harwich (and occasionally at Margate) waiting for the wind, on his journeys to the field of victory?—apart from the hindrance to his military plans in 1707 through continued bad weather in Flanders.

When Admiral Lestock took out a fleet to the Mediterranean at the close of 1741, he was delayed many weeks by head-winds on the voyage, and arrived with ships so shattered and strained by the rough weather, and with crews so sick, that the long-expected reinforcement was of no immediate use.

The head-winds which so often baffled Nelson are historic. In the same way, for two entire months, was the military force of Sir David Baird detained by contrary winds at the mouth of the Red Sea when on its way from India to Egypt, in 1801, to expel the French from the valley of the Nile.

Among naval reminiscences of the past century is one of Captain Inglis, when in command of H.M.S. *Petrel*, leading the fleet under Lord Keith, in January 1801, into the roads of Marmorice during the height of a gale under press of canvas. In the same part of the world, in March 1807, Sir John Duckworth—it being in the days of sailing ships—had considerable difficulty in extricating his ships, owing to persistent contrary winds, for several weeks from the Sea of Marmora during our hostilities with the Turks. It was a very fortunate circumstance that the vessels were adequately victualled and supplied with water, and that the Turks were slow in equipping their defences.

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[1] Unable to get at the foe, Howe was twitted with merely watching him:—

"Howe sua nunc brevius verbo complectitur uno
Et VIDI nobis omnia gesta refert."

When windbound in Torbay the other cheek was smited by lampoons, etc., *e.g.*:—

"Somebody, too, by some delay,
Somebody, the other day,
Let the French Fleet slip away,
You know How."

When in the following year, in October 1808, Sir Hudson (then Colonel) Lowe was attacked by the French at Capri, he applied for assistance to Sir John Stuart in Sicily, who, without waiting for convoy, at once hurried off reinforcements which would, ordinarily, have arrived in time. A very strong gale sprang up, however, and blew hard in their teeth, delaying them on the voyage, which was not a very long one, and they arrived off Capri a few hours only after Lowe had been obliged to capitulate to General Lamarque.

Many were the anxieties of the Duke of Wellington in Spain when the transports with drafts, munitions, and other supplies from England were either wind-bound or blown off the Spanish coast by contrary winds.

INVASIONS HELD IN CHECK.

Great was the destruction of the invading fleet of Mardonius off Mount Athos, 493 B.C. No less than three hundred vessels perished, and the shores of the Strymonian Bay were strewed with innumerable Persian corpses.

One of the earliest great operations of war was the invasion of Europe by the Persians under Xerxes after Egypt had been again reduced by them to submission. Troops were collected from all parts of the vast Persian empire, magazines built and stored with food, and a fleet numbering over three thousand triremes prepared. A double bridge of boats was thrown across the Dardanelles to expedite the march of the troops. Hardly had the latter begun when a tempest sprang up and swept away the bridges. The engineers were put to death to encourage their successors, and fresh bridges were more stoutly constructed. Even before quitting Asia further difficulties beset the expedition. Heavy storms continued, and blew down from Mount Ida while the army was on its march through the Troad, and the Scamander, whose waters were drying up, offered a warning of the troubles threatening in ill-watered countries. Later on, too, the North-east blasts from the Pelion Range struck the triremes on their way to the Gulf of Volo, with a heavy loss both to vessels and crews. Still later, when off the coast of Eubœa in July, a night of wild storm and rain smote the Persian fleet, and two hundred ships were destroyed at one time. After the decisive battle of Salamis (480 B.C.), Xerxes' retreat through Thessaly was jeopardised. On his retirement to the Dardanelles each day his difficulties increased. The bad season of winter arrived prematurely with snowstorms and great cold, the Thracian rivers were covered with treacherous ice, the native tribes could no longer be trusted when the fortune of war had changed, and supplies of provisions and animals were not forthcoming; the most necessary arrangements had not been made in advance, and hunger and disease swept away both men and beasts. Only the miserable remnants of a weather-beaten army in a state of dissolution remained for Xerxes to lead across the Hellespont, the bridges over which had been carried away a second time in the great storm; and even when on the southern side great numbers still perished from the exposure and privations of the long march, and the seeds of disease engendered during the hardships of the campaign.

The difficulties encountered by Xenophon at the head of the 10,000 Greeks in the march through Armenia, from ice, snow, and the storms of winter, will be remembered.

The Norman fleet for the invasion of England in 1066 was assembled at the mouth of the Dive early in August, but was delayed for a month in port by contrary winds. In the second week of September it set sail, but was blown back, with loss of several vessels, into St. Valery, where it was again weather-bound for over a fortnight, during which William offered constant prayers for the desired Southerly wind, and finally caused the relics of St. Valery to be borne in solemn procession. The result was immediate. On September 27 the wind shifted round and the fleet sailed; the Conqueror embarking, appropriately, in the ship called *Mora* (one presented to him by his wife), and, after a night passage, landing at Pevensey three days after Harold's victory at Stamford Bridge over another invader.

In the reverse direction, when William Rufus, in the spring of 1094, invaded Normandy from England, his ships were detained by contrary winds for six weeks at Hastings.

Haco's Norwegian invasion of Scotland in 1263 was frustrated by a severe storm.

In Henry the Third's time the invasion from Flanders in 1264 was altogether stopped by unfavourable winds, and perhaps also a little by the knowledge that the redoubtable Simon de Montfort was prepared to deal with it on landing.

If Edward the Fourth's landing in England was delayed by contrary winds, so Queen Margaret's invasion in 1471 was similarly hindered by bad weather. The Queen embarked at Harfleur with her son on March 24, but the wind prevented her progress. "At divers times they took the sea, and forsook it again." It was April 14 before the royal vessel entered the harbour of Weymouth,—the eventful Easter Sunday on which the battle of Barnet was fought—so fatal to the success of her expedition.

Henry the Seventh also started from Harfleur in 1485, and in summer-time, but even then took a week beating round the Land's End before he succeeded in entering Milford Haven. (Two years previously—1483—his expedition of fifteen ships, with 5000 Breton allies, was entirely dispersed at sea by gales; and though Henry Tudor himself sighted Poole Harbour, he found it safer then to return to Normandy.)

In January 1560 the Marquis d'Elbœuf set sail with a fleet for Scotland to aid Mary of Guise (mother of Mary Queen of Scots), but so rough were the gales that the whole armament had to put back to France.

The buffeting of the first Spanish Armada in 1588 all round our coasts is historic. Essex's expedition to Spain in 1597 was little more fortunate. The second Spanish Armada, in the same year (1597), got as far as the Scilly Isles before it was blown back, losing many vessels in the Bay of Biscay. More than a century elapsed before the third Spanish Armada left Corunna for these shores in 1719. But the fleet, with the troops on board, was dissipated off Cape Finisterre by a hurricane which raged for twelve days, and only two frigates reached the coast of Scotland, off Stornoway. These surrendered after the action in the Pass of Glenshiels on April 1, and thus ended the attempt of Cardinal Alberoni to retrieve the disasters of Philip.

In 1651 three regiments of Parliamentary troops were despatched from Chester and Liverpool for the invasion of the Isle of Man. They encountered, however, the customary fate of invaders—contrary winds,—and were driven back to take shelter for nearly a fortnight in Anglesea, off Beaumaris.

The winds were busy in the autumn of 1688. "On October 16," says Bishop Burnet, who was on board, "the wind that had stood so long in the West came into the East. On the 19th the Prince [of Orange] went aboard at Helvoet Sluis, and the whole fleet sailed out that night. The next day the wind turned North and settled in the North-west. At night a great storm arose. We wrought against it all that night and the next day, but it was in vain to struggle longer. So vast a fleet ran no small hazard, being obliged to keep together and yet not to come too near. On the 22nd the greater part got safe back into port. After a few days all came in—some ships so shattered that when all was taken out they immediately sank. Five hundred horses died for want of air. . . . It was a continued storm for some weeks. On October 27 there was for six hours together a most dreadful storm. On November 1 we sailed out on the evening tide—the wind was strong and full in the East. This wind also kept the English fleet in the river."[1]

Lord Dartmouth's fleet was lying in the Gunfleet when the Prince of Orange's was seen on November 3 making its way west, transports and all, in a hard gale. Tide and wind against, Dartmouth was obliged to lie at anchor until the following day, when he got to sea in pursuit. A Council of War was held "if they were to fight"; but it was unnecessary, as the wind veered to West.

The Prince had no sooner landed at Brixham than, says the Bishop, "a new and great storm blew from the West, from which our fleet, being covered by the land, could receive no prejudice. The King's fleet, which was come as far as the Isle of Wight, tried what they could to pursue us, but they were so shattered by some days of this storm that they were forced to go into Portsmouth, and were no more fit for service that year."

The visitor to-day to Brixham is somewhat puzzled—he is shown the spot on which King William the Third landed in 1688 on a pier which was built in 1814!

In the spring of 1708 Fourbin's descent upon Scotland was baffled by tempestuous weather, though the French vessels actually entered the Firth of Forth, and the expedition fell back to Dunkirk with a loss of over four thousand men.

To change to another hemisphere—the expedition against Quebec which left Plymouth in May 1711 arrived across the Atlantic at the end of June. Delayed, waiting for supplies and reinforcements, the ships did not enter the St. Lawrence until the beginning of August. As they approached the river it came on to blow, and on the 21st, when off Gaspé, a dense fog and strong Easterly gale compelled the fleet to lie to for the night. On the 22nd the flagship *Edgar* was leading, when she found herself in the breakers off the Egg Islands, and narrowly escaped. Eight transports, however, were wrecked, with a loss of over 900 lives, and the rest of the fleet was saved with the greatest difficulty. The stormy weather continuing, the pilots refused to carry the fleet up to Quebec, and the ships were insufficiently victualled for any protracted effort. The vessels (containing 6000 soldiers ill-spared from the Duke of Marlborough's scanty force in Flanders) returned to Spithead—where the *Edgar* blew up with all on board!

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[1] O nimium dilecte Deo, cui militat aether
Et conjurati veniunt ad classica Venti.

(Heaven's favourite for whom the skies do fight
And all the winds conspire to guide thee right)

quotes the Bishop from Claudian.

When the Russian fleet in the Black Sea, in 1738, was shattered in a gale, the land-forces of the Muscovites in the Crimea were compelled to withdraw, being no longer provided for and supported by a naval force, and having no roads, canals, or railways to draw from.

In December 1796 the military expedition sent by the French under Generals Hoche and Grouchy to invade Ireland arrived in Bantry Bay, but encountered such an alternation of fogs and storms that the ships were scattered on the voyage and unable to land their troops on arriving in such wild weather. Many of them were wrecked, and the remainder returned to France. A powerful Dutch fleet with 30,000 troops on board was intended to co-operate in this Irish invasion—while at this time the British fleet was unhappily paralysed in port by the great mutiny. Admiral Duncan was left off the Texel with two ships alone to endeavour to keep up the blockade of the enemy's entire fleet. (The two observing ships just mentioned made daily a series of signals apparently to the rest of the fleet at a greater distance, but which really did not exist.) Fortunately for England, a long spell of persistent Westerly wind kept the Dutchmen in port until the English ships returned to duty and rejoined Duncan in time to take part in the victory of Camperdown in October 1797.

Napoleon's invasion flotilla in the English Channel suffered great damage in July 1804 from a Northerly gale—gales from that quarter being unexpected about midsummer—and many gun-vessels and flat-bottomed troop-boats were destroyed.

One may be pardoned a brief digression. When a quarter of a million of fighting men and the horses and supplies belonging to them were sent out recently to South Africa not a single transport was lost. Steam and large vessels had shown how successfully a huge invading army can be conveyed if the security of the seas can be depended upon. A still more recent echo of this fact comes to us from the coast of Manchuria.

WIND EFFECTS ON OPERATIONS.

The effects of wind in hindering the operations of war are naturally chiefly felt at sea.

Thus in 1343, when a sea-fight had begun between the Spanish fleet under Don Luis d'España and the English squadron under the Earl of Richmond, a gale sprang up so rapidly that it was impossible to continue the engagement, and the ships separated. It was then the period of small vessels and very short ranges.

On land the Moors in 1481 succeeded in capturing the fortress of Zahara in Andalusia by surprise, scaling the defences in a furious tempest which covered the sounds of their approach, which was not so difficult, as their weapons were light and no accoutrements were worn. In a similar way, the year following, the Spaniards, under Ponce de Leon, possessed themselves of the citadel of Alhama, the night being also dark and tempestuous.

The ill-fortune of the naval expedition of 1597 under the Earl of Essex—twice crippled by storms—has already been alluded to. Another unlucky attempt was that intended to aid the Protestants beleaguered at La Rochelle by Cardinal Richelieu—the expedition to the islands in its vicinity in 1627. The reinforcements sent out in October under Admiral Wilmot were delayed for want of supplies at Plymouth, and on leaving that port encountered such heavy gales in the Channel that they were compelled once more to return home. In consequence of the non-arrival of the fleet on the French coast, the Duke of Buckingham was compelled to retire from the islands.

The Earl of Sandwich's attempt upon Algiers in 1661, was also frustrated by the weather. A strong Easterly wind and rolling sea prevented the fleet from attacking, and this weather continuing for some time the project was given up.

It was owing to persistent head-winds and rough weather that Admiral Killigrew's fleet took no less than thirty-five days, in 1690, to beat into Plymouth from Cadiz. The result was momentous. Owing to this protracted passage the ships arrived too late to take their share in the battle off Beachy Head, and consequently the French were victorious.

In 1692 "God alone delivered us," said Queen Mary the Second, by the winds which contributed to the decisive victory of La Hogue (or Barfleur) and permitted the English ships to force their way through the French line of battle before the action was stopped by fog (see p. 106).

On land the wind has been sometimes turned to special account, as at the passage of the Dwina by the Swedes in 1701. The Saxons being encamped on the south side of the river, use was made of the strong North wind by the firing of vast quantities of the straw, duly wetted, in the Swedish camp. A dense smoke swept across the river, completely hiding the movements of the Swedish troops. Under cover of this dense cloud several boats sneaked across loaded with still more straw, which was then ignited on the south bank and nearer the enemy, completely blinding and stifling them and rendering it impossible for them to know if the passage of the river was being attempted or not. When the Swedes at last did cross, the enemy's forces were so confused and blinded by the smoke that their guns were worked at random and with little effect. Indeed, as soon as their aim was discoverable the Swedes were able to avoid their fire in their advance.

The complicated manœuvres off Malaga in August 1704, when each of the contending fleets, those of the Comte de Toulouse and of Sir George Rooke, held the weather-gauge in turn, and when the battle was suspended just as it was beginning, form an interesting example of the great difficulties attendant on naval warfare before the days of steam.

Though there is little perceptible tide in the Baltic, the wind exercises great influence on its shallow waters. Thus during the siege of Stralsund in 1715 the fortress was protected on the west by an impassable morass, and apparently by the sea on the east, yet a strong West wind blowing for several days together in the autumn lowered the depth of water below the fortifications to only 3 feet. This was first discovered by the enemy, and the Danes and Prussians succeeded in wading through the water and surprised the garrison on a side very ill-guarded, not being supposed to be liable to attack.

Some years later this operation was paralleled in the Black Sea. When Field-Marshal Lacy invaded the Crimea at the head of a Russian army in the summer of 1738 for the second time he created a diversion by threatening the isthmus of Perekop. Having occupied the attention of the enemy, he succeeded in turning the Turkish position by a cleverly devised flank attack over an arm of the Sea of Azof. This inlet, somewhat shallow in the summer months, was unprotected by any high ground, and so exposed to the wind which, on occasion for many hours consecutively from the West, drives back the water. The marshal waited for his opportunity, and when, on July 7, the wind rose in the right quarter and lowered the water sufficiently, marched his forces rapidly across before the breeze went down and the sea regained its level. As it was, a few baggage wagons lingering behind with tired horses were engulfed, the wind having dropped just as the columns reached the opposite shore. The Turks, thus taken in the rear, were speedily driven out of their defences, and the famous lines of Perekop fell into the hands of the Russians.

To note another wind effect upon currents. When Admiral Vernon returned from his attack upon the Spanish colonies in the West Indies, he reached the Bristol Channel at Christmas 1742. He had experienced an exceedingly boisterous passage across the Atlantic, and was compelled for many days to take shelter under Lundy Island, having been driven out of his course for the English Channel by the strength of Rennell's Current, which had been intensified by the winter gales.

Still more dogged by rough or unfavourable winds was Sir John Norris—indeed so much so that that gallant admiral received from the tars of the fleet the sobriquet of "Foul Weather Jack." In February 1734 he succeeded in surprising the French fleet off Dungeness—but his old luck still clung to him! "The night set in wild and dark. The wind (previously South-west) flew round to North-east, and increased in strength until about 1 a.m. the storm broke out with excessive violence. Most of the English ships parted their cables and were driven out to sea by the fierceness of the storm. The French ships slipped their moorings early in the evening, and, leaving their anchors, got away before the wind, unperceived."

Howe's first and unsuccessful attempt upon Cherbourg in June 1758 was frustrated partly by windy weather as well as by the procrastination of the military commanders. He was more fortunate in the autumn, however, and totally destroyed Cherbourg, but, stormy weather again coming on, was unable to accomplish anything at St. Malo.

When General Tarleton, one of our most able and successful generals in North America, left New York for Charleston in December 1779, he lost nearly all his cavalry horses on the voyage owing to the tempestuousness of the weather, and consequently his earlier movements on landing were much circumscribed. Even cycles in those days were not available as substitutes. Still he managed to carry out his instructions to invest Charleston, and, in May 1780, to capture it.

The loss of Admiral Rodney's prizes taken from the Comte de Grasse, when sent home under Admiral Graves, in the autumn gale of 1782, will be remembered, as well as that of those taken at Trafalgar by Nelson in the autumn of 1805. "Captain Blackwood" says the historian James, "delivered to the new Commander-in-Chief Lord Nelson's dying request that the fleet and the prizes should anchor, having regard to the proximity of the shore and the prospect of a gale. 'Anchor the fleet!' said Lord Collingwood, 'why, it is the last thing I should have thought of!' Accordingly it was *not* done, and the consequences followed." The anticipated gale sprang up, and the dearly bought fruits of victory were thrown away.[1]

General Hoche's attack upon the Royalist forces at Quibéron in July 1795 was masked by the raging of the Atlantic. On the night of the 20th the Republican troops advanced along the shore, while the loud roar of the foaming breakers driven before the storm prevented their footsteps from being heard in the fort above. Menaye's detachment boldly entered the angry surf to wade round the rocks on which the redoubts rested. The sea was waist-deep, and so turbulent that a number of his men were swept away and could not recover themselves, but sufficient managed to clamber up the rocky ascent to the fort on the side steeply overhanging the restless ocean. Hoche at the same time made his attack on the land side, but his men were early discovered and were being driven back, when the shouts of Menaye's surviving grenadiers were suddenly heard even above the roar of the gale, and the flashes from the guns revealed the tricolour flying on the highest part of the fort. The Royalists, thus taken between two fires, were routed and driven out headlong.

From the time of the battle of Fleurus in 1794 the balloon has been experimentally employed at first, but more frequently latterly for purposes of observation in war. It was used in 1859 at the battle of Solferino, by the Federals in the American Civil War, by the English forces at Souakim, at Magersfontein in 1899, at Paardeberg with excellent results in 1900, and in Manchuria recently.

Used for carriage during the investment of Paris in 1870-71, the direction and speed of the wind was of vital moment when the balloons left the beleaguered capital with despatches for the temporary seat of Government at Tours. In October 1870 Gambetta left Paris by this means; and altogether, when the wind permitted it, between sixty and seventy balloons were dispatched with passengers and letters, etc., during the war in France.

The use of dirigible balloons or air-ships in the future, while it indicates another phase in which the weather will play an important part, is so large a subject that it is best not to touch upon it to-night.[2]

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[1] In April 1799 a very plucky action was fought off L'Orient between two frigates under Sir Harry Neale and three French frigates which were being blockaded there. A very sudden squall dismasted one of the English frigates, the *Amelia*, whereupon the three Republican vessels sallied out and engaged the disabled blockading force, but were beaten off and sent back into port.

[2] Though not strictly pertaining to war, a curious story in connection with balloons

BATTLES IN STORMS.

The most notable instances of battles fought in storms[1] are :—

On land those of—

Malmesbury in 1153, where the rival forces of Henry the Second and Stephen confronted each other on opposite sides of the river Avon. Both commanders were at the head of their respective troops drawn up in readiness for the battle, but it hardly began before a storm, which had been blowing up from the West, culminated, beating in the faces of the king [Henry] and his men with such violence that they were compelled to retire, being almost helpless, as their arrows could not fly against so high a wind.

Towton, in March 1461, when the Lancastrian archers were blinded by a thick snowstorm driving against them, and so were unable to make any effective reply to the arrows of the Yorkists.

Falkirk, in January 1746, when General Hawley's men had to contend against a violent storm of wind and rain which beat in their faces and damped their powder as well as their courage.

Culloden, in April 1746, where this time the English infantry had the wind at their backs, and so the smoke from their muskets cleared, blowing over towards the enemy, who was embarrassed by it.

And in the summer of 1859 the bloody battle of Solferino opened in almost tropical heat. It was nearly the longest day of the year. "As the hours wore on," says one who was present on the field, "the sky became overcast and thick clouds obscured the horizon. The wind rose to a furious gale, tearing branches off the trees and whirling loose articles about in all directions. Icy rain descended, drenching to the skin the combatants, already suffering from hunger and fatigue of marching; and whirlwinds of dust, of hail, and vivid flashes of lightning illumined the gloom and half blinded the soldiers, who seemed engaged in ineffectual contest with the elements at the same time as they were warring against mankind."

At sea,—

Lord Hawke during his watch on the French fleet had persistently struggled against continuously bad weather all through November 1759. He had been driven off the French coast twice into Torbay, and on getting back to his station he found that the French fleet had got out of Brest. Despite a heavy gale coming on, Hawke crowded on all sail possible and so managed to overtake the ships of Mons. de Conflans off Quibéron. All day it blew harder and harder. The French admiral crowded on every stitch of canvas the wind permitted, and the English ships did the same. Hawke was warned by the master that his vessels would run ashore, and replied that "the French would first. Until *then* every sail must be kept up." Nine of the French battleships were driven ashore, captured, or destroyed, and the rest took no further part in the war. Two of the English vessels ran aground in the pursuit.

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appears in Mr. Carl Jeppe's work on the Transvaal. When the water supply ran out in the early days of Johannesburg an attempt to attract rain was made by exploding dynamite from balloons. The Boers, however, were horrified at what they regarded as an affront to Providence, and immediately introduced a Bill in the Raad to forbid any repetition, on the ground that it was a defiance of the Almighty and nothing short of sacrilege.

[1] Crécy has been previously mentioned, also other battles under "Snowfall."

Another great sea battle in a storm was fought off Cape St. Vincent in January 1780. Admiral Rodney's fleet on its way to Gibraltar overtook, being better craft, a Spanish one under Don Juan de Langara on its way to Cadiz. "Night closed in," says Professor Laughton, "as the action began, and through it a fearful storm was raging, but neither darkness nor storm stayed the brilliant onrush of the English fleet. Of nine Spanish ships engaged, only two escaped. The circumstances of the action, the darkness, the storm, the rocks to leeward, enhanced the merit of Rodney's prompt decision." During this wild scene one of the enemy's vessels which had taken fire blew up. Gibraltar, which was then closely blockaded by the Spaniards, was at once relieved.

Few more graphic pictures have been drawn than in the pages of James's *Naval History*, where, devoid of all embellishment, the narrative of the wreck of the *Droits-de-l'homme*, one of the invading squadron returning from Ireland, is given. The grim earnestness of war—the chase to the dead end [1]—the bloody conflict and the awful results of the fury of the Atlantic, combine to enhance the luridness of the scene.

On January 13, 1797, the *Droits-de-l'homme*, a 74-gun ship, was sighted in foggy weather and chased by two English frigates, the *Indefatigable*, 44 guns, and the *Amazon*, 36 guns. The French man-of-war had over 1300 men on board, including General Humbert. The wind blew heavily dead on shore, and the French commodore was powerless to arrest the course of the ship, which ran aground in a furious South-west gale soon after dawn in the Bay of Audierne. The waves swept over the wreck, carrying away many victims. Previously to this the ship had been engaged at close quarters for many hours during the night with the two frigates, and all three vessels had sustained a heavy loss of life in battle. This would have been still greater had not so terrific a sea been running, which prevented the lower deck ports being opened. The heavy guns, too, broke loose from the rolling of the vessels, tearing the ringbolts from the decks. At 4 a.m. the *Indefatigable* discovered land right ahead, and went about as speedily as the gale would permit, passing in the grey of dawn her late opponent ashore, but was quite powerless to afford any succour. It was a continued suspense, and long struggle with the elements, before, at nearly noon, the *Indefatigable* drew clear of the rocks and got out to sea.[2] The *Amazon*, less fortunate, being also much crippled in the action, struck the shore, and her crew, escaping on rafts, except six, were made prisoners. Though the beach was crowded with spectators and troops, no help could be given to those on board the *Droits-de-l'homme*. By slow degrees four or five hundred men were washed overboard and drowned, or lost in fruitless attempts to reach the shore. On the second day the waves broke through into the hold and washed out all food. The sea on the third day was still running mountains high, and in the billows were floating on all sides bodies of the victims. On the fourth day the extremity of hunger was so keenly felt that the survivors were casting lots who should be sacrificed for food, when a French brig came in sight and anchored close enough to take off about 150 men, out of 400 who attempted to get off, on rafts. Three hundred and eighty were still left on board the *Droits-de-l'homme*, and when the fifth day arrived over one half of these were found to have died in the night. Such are the horrors of war when intensified by the elements.

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[1] Compare Sir Richard Keats in the *Galatea*, in the summer of 1796, pursuing the *Andromaque* through the shoals of the Garonne until she was driven ashore and burnt.

[2] Pellew, the commander of the *Indefatigable*, was a fine seaman. In the previous year a West Indiaman was driven ashore at Plymouth under the Citadel in a violent gale. Her masts went overboard and the ship was breaking up. The captain was away, the officers of the ship were young and unequal to the emergency, the crew were panic-struck, and the soldiers on board drowned their despair in the spirit room. Pellew happened to be at Plymouth, and running down to the shore, contrived to get on board and took the command, and by his exertions every one on the ship was landed by means of hawsers before the wreck broke up.

PERSONAL ESCAPES.

Themistocles, the victor of Salamis, was once almost blown into the midst of his enemies, while on his flight to Persia, by a North gale setting in suddenly when off the isle of Naxos.

When Germanicus was setting forth on one of his campaigns Tacitus relates that his ship was driven ashore in a violent gale on the coast of Holland, and he was nearly made prisoner.

The celebrated Danish pirate Regnar Lodbrog was driven by a storm on to the Norfolk coast, and being captured, lost his life. Richard the First was made prisoner through a storm in the Mediterranean.

Longespee, Earl of Salisbury, was caught in a tempest as he was returning home from the wars in France in 1225, and his goods were cast overboard to lighten the vessel. While the storm was at its height both he and the crew saw a great light (it was perhaps St. Elmo's fire?), and a lovely maiden standing, it seemed, at the mast-head, whom he supposed to be the Blessed Virgin—for from the day of his knighthood he had ever provided a taper to burn at her altar—come to their succour. The ship was driven by the gale ashore on the Isle of Rhé, yet he managed to escape from the enemy, and, getting afloat again, landed in Cornwall (after a voyage of no less than three months), when he had been given up as dead. When he actually died in the following year, it is related, as a proof of his salvation, that though carried from the castle to the cathedral at Salisbury in a storm of wind and rain the funeral torches were not extinguished!

The great Columbus—treated with an ingratitude equalled only in the cases of Belisarius, Warren Hastings, or Lord Dundonald—had been arrested, actually placed in manacles, and thrown into prison by Bobadilla before being sent back in irons from the Indies to Spain. Having vindicated himself, once more did Columbus cross the ocean and reached Hispaniola. On arriving off the port the signs of an approaching storm—(this was in 1502, the barometer was not discovered until 1643)—caused him to counsel the governor of Hispaniola to delay the sailing of a fleet then in harbour under orders to convey Bobadilla and the rebels with their ill-gotten treasures back to Spain. The governor peremptorily declined to postpone the sailing of the fleet, and even refused to allow Columbus with his ships to take refuge in the harbour. The apprehensions of the experienced mariner were fully justified by the event. Scarcely had the Spanish fleet quitted its moorings before one of those tremendous hurricanes came on which so often desolate these tropical regions, sweeping everything before it, and fell with such violence on the little navy that out of eighteen ships of which it was composed not more than three or four escaped. The rest all foundered, including those which contained Bobadilla and the late enemies of Columbus. Two hundred thousand *castellanos* of gold, half of which belonged to the Government, went to the bottom with them. The only one of the fleet, strange to say, which made its way back safely to Spain was a crazy weather-beaten bark which contained 4000 ounces of gold, the property of Columbus. To complete these curious coincidences, the great discoverer and his little squadron rode out the storm in safety under the lee of the island, where he had taken shelter on being so rudely repulsed from the port.[1]

Philip of Spain, when leaving the Low Countries, was driven by a tempest to take shelter in an English port—Weymouth or Falmouth, historians differ as to which—in January 1506. Both the future King and Queen were detained for three months in England, and were only released by Henry VII. upon exceedingly onerous conditions.

Sir Edward Paget, second in command of the English force in the Peninsula in 1812, in the fog and darkness of a severe storm near Ciudad Rodrigo, riding across country from one column to another alone, was captured by the cavalry of Marshal Soult.

Many other illustrations of eminent persons, mostly in times of war, experiencing the perils of the ocean may be cited. When the Roman Pompey was adjured by his friends not to put to sea in a violent storm, he replied, "It is necessary to sail—it is not necessary to live."

The bark which bore Cæsar and his fortunes escaped, says Plutarch.

ROYALTY AT SEA.[2]

When William Rufus hurried across the Channel to suppress a rebellion in Normandy in 1099, the master of the ship he was embarking upon remonstrated, saying that the weather was "too stormy to put out." "Hold thy peace, knave," said William, "kings are never drowned."[3] So too Alexander the First, King of Scotland, had a narrow escape from shipwreck. King John only lost his luggage in the Welland. Henry the Second, Richard the First, and Edward the Third have been already referred to. Edward the Fourth, tempest-tossed from Cromer to the Humber in 1471, landed safely at Ravenspur. Arthur Plantagenet, a son of Edward the Fourth, going to the wars, was caught in a fierce gale off the coast of Brittany in 1513, and was all but wrecked. When hope was abandoned, he called upon Our Lady for help, offering, if it pleased God and Her to deliver him out of peril, that he would not eat flesh nor fish until he had seen her shrine at Walsingham—a vow which he kept; and was again saved from shipwreck in 1532. Gustavus Adolphus, during the war between Sweden and Denmark, narrowly escaped drowning in 1612; his horse, slipping down, broke through the surface of a frozen lake, and immersed both steed and rider. James the Second, when Duke of York, had an exceedingly narrow escape when the vessel he was on was shipwrecked between Yarmouth and the Humber.[4] On one occasion George the Second, when returning to this country from Hanover, insisted on crossing in the teeth of a violent storm. Admiral Wager advised a postponement. "Let it be what it will," said the King, "I'm not afraid"; to which the gallant admiral responded laconically, "If you are not, I am, your Majesty." When the vessel was driven back the following day to Helvoet Sluys, the King was obliged to admit that the admiral's advice was justified. The Duke of Wellington, in 1801, was on the point of sailing from Bombay for the Red Sea with Sir David Baird's expedition to Egypt, but was taken ill at the last moment. Happily; for the *Susannah*, on which he was to have embarked, was lost with all hands, in the Red Sea.

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[1] Prescott's *Ferdinand and Isabella*, vol. ii. p. 448.

[2] The loss of *The White Ship* was not due to weather, but ale.

[3] Pharaoh might be quoted as an exception.

[4] A good account of the Duke of York's escape will be found in *Sir Henry Ellis's Letters*, Second Series, vol. iv. pp. 66-72.

With exception of Margaret, the Maid of Norway, who died on her passage to Scotland in 1290, after much tossing by the elements, but who was in very fragile health when she started, the ladies seem to have been equally fortunate.

It is true that in 1325, while vessels were still extremely small, Isabella, queen of Edward the Second of England (after her husband's defeat by the Scots), had so stormy a voyage, that two of her attendant ladies died of the hardships encountered on the passage. Queen Margaret's vicissitudes have already been alluded to.

In the summer of 1561, Mary Queen of Scots succeeded in getting back to her native country without being intercepted by Queen Elizabeth's cruisers. On reaching Leith, however, the sea-fog was so thick that the ships had to lie off the port until it lifted sufficiently for them to grope their way, on the following day, into harbour.

Anne, queen of James the First of England, was nearly wrecked in October 1589 on the coast of Norway, and several unhappy "witches" were in consequence barbarously burnt at the stake, in her native country Denmark, for being the cause of such stormy weather. King James, who came over the North Sea to meet his bride, was detained a whole winter in Norway by the tempestuousness of the season, and his own caution.

In 1643 Queen Henrietta Maria sailed from Holland, with close upon a million in specie, to join King Charles. She was overtaken by a very violent gale, and the ship was temporarily driven back to the Dutch coast. "Comfort yourselves," said Henrietta Maria to her frightened ladies-in-waiting, "Queens of England are never drowned." Neither were future Queens, and the Princess of Orange survived her trying honeymoon voyage from Margate to Ter Heyde in 1677. (Her husband's voyage of invasion eleven years later has been previously mentioned.)

When William III. went over to the Continent in 1690 a violent storm caught him off the Hook of Holland, and he was for sixteen hours in great danger. When the seamen became apprehensive the King said in a very intrepid manner, "What! are you afraid to die in my company?"

WRECKS.

Through financial stress, and latterly by the protracted wars, many of the royal vessels ended their days more by unseaworthiness than stress of weather. For example, as far back as the summer of 1637 the *Fifth Whelp*, when off the Dutch coast, straining in a fresh breeze, sprung a leak so suddenly that part of the crew went down in her. Still more tragic was the end of the *Royal George*, which fell to pieces at Portsmouth when fitting out in 1782 to go with the fleet to the relief of Gibraltar, and the admiral (Kempenfeldt) and over seven hundred men perished. The gallant Troubridge, the companion in arms of Nelson, too was lost off Madagascar, caught in a gale in a worn-out ship, the *Blenheim*, in 1807, and the whole crew perished.

Plimsoll had not then lived!

It was the wreck of the frigate *Anson* in a heavy gale in Mount's Bay in December 1807, with heavy loss of life, that stimulated Henry Trengrouse to invent the life-saving rocket apparatus.[1]

Gales have hindered in secondary ways the operations of war. In October 1799 the frigate *Lutine* was caught in a North-west gale off the coast of Holland, and foundered with a large quantity of specie on board. Only two of the crew were saved. Many attempts have been made to raise the specie, but only some eighty thousand pounds has been recovered out of a million and a half on board—and military pay must have got into arrear!

In 1855 we have, too, the disastrous loss of the transport *Prince* in the Black Sea with stores and winter clothing for the British troops in the Crimea. Such was the force of the storm that barely a tent was left standing in the entire camp, and the more ponderous articles of furniture, such as chairs, tables, and tent-poles, were blown about as lightly as caps, garments, and bed-clothes. The rain fell in torrents and flooded the whole camp, which presented a scene of ruin and desolation, the officers and men seeking shelter where they might from the fury of the elements. The damage done during this hurricane caused much of the suffering of the army during the winter, which now increased in severity from week to week. The hardships undergone by the British soldiers during these months were indeed great. They suffered from want of shelter against rain, wind, snow, and cold, from insufficient and barely cooked rations, from want of clothing and fuel, and from short numbers for duty, the hospitals being crowded by those broken down by the stress they had undergone.

One episode in war-time is worthy of especial mention—viz. the saving of H.M.S. *Magnificent*, 74 guns, from almost certain destruction by the splendid seamanship and resource of her captain, Hayes, on December 17, 1812,[2] when among the rocks in the Basque Roads, in a heavy South-west gale. The account is a most exciting one and should be read in full. It is a parallel, under canvas instead of steam, to the fine escape of the *Calliope*, Captain Kane, in recent times from the hurricane at Samoa.

A picture, by Schetky, of another episode in the long French war exists, of an English frigate bearing down in a gale of wind at great peril to the rescue of a French ship of the line, when embayed on a rocky coast.

SEVERE GALES.

In 1378 the Earl of Buckingham's fleet on war service off the coast of Flanders was scattered by a gale of extreme violence.

In 1379, after repulsing a descent on Cornwall by the French fleet, the squadron of Sir Thomas Arundell was destroyed on the south coast of

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[1] Captain Manby devised one of some similar character about the same time.

[2] The details will be found in the *Naval Chronicle* and in James's *Naval History*.

Ireland—a punishment, according to Thomas of Walsingham, due to the sailors having carried off to sea with them the fair occupants of a convent near Southampton. When the tempest was at its height the unhappy nuns were thrown overboard to lighten the ships; twenty-five of which vessels with their admiral and most of their crews perished in the storm. The great soldier Sir Hugh Calveley fortunately escaped, being washed ashore with seven sailors. The Earl of Buckingham's fleet in the Channel was on this occasion more lucky, escaping without loss—the Monk of Evesham ascribes its better fortune to the superior piety of the crews in paying their debts (to the Church ?) when in port.

The hurricane of February 1694 at the entrance of the Mediterranean was a most disastrous one, and caught Admiral Wheler's fleet off Malaga. His flagship foundered, with himself and all on board (except two persons), and many other vessels in the fleet were driven ashore at Malaga and in Gibraltar Bay (then wholly Spanish). The English naval campaign in the Mediterranean was in consequence much delayed.

Admiral Sir John Leake had just returned from the Mediterranean when "the great storm" (November 27, 1703) broke, and his flagship, the *Prince George*, was the only one of all the ships in the Downs which rode out the gale. Admiral Sir George Rooke was on the Dutch coast with a small squadron, nearly all of which were either badly damaged or stranded. In Admiral Sir Cloudesley Shovel's fleet in the Channel, nine ships of the line were lost besides four others with fifteen hundred hands. The remaining vessels were strained and crippled.

It was, however, four years later off Scilly that Sir Cloudesley Shovel lost his life in the Westerly gales of October 1707, when the *Association*, *Romney*, and *Eagle* were wrecked (and the rest of the fleet escaped with very great difficulty) on their return from the attempt upon Toulon.

In 1746 occurred a memorable hurricane which shattered the French power in India. Mons. de La Bourdonnais was holding the command of the sea when in October his ships were caught in the open roadstead of Madras by a cyclone, wrecked, battered, or dispersed in a few hours.

In 1780 the whole English fleet in the West Indies was disabled by the great hurricane. H.M.S. *Phœnix* was wrecked off Cuba, and the other warships which escaped going ashore were so shattered that any naval movements were paralysed for some months.

Yet worse were the historic storms of 1795. Admiral Sir Hugh Cloberry Christian had barely left port in November with the expedition intended for the West Indies than a violent gale sprang up. The fleet, besides the men-of-war, included 200 transports with troops and stores. Many of these foundered or were driven ashore; over 200 dead bodies were picked up in the neighbourhood of Chesil Beach, and the expedition had to put back. It sailed again in the middle of December, to meet with an even worse gale, which dispersed the ships, and a large number were wrecked, and some driven back again to England. The fate of the 88th Regiment going out with General Beresford indicates how far-reaching were the effects of these memorable gales. Two companies of that regiment arrived safely in Jamaica—the surgeon arrived by himself at Barbados—one company was blown right through the straits of Gibraltar into the Mediterranean, and the rest of the companies back to different English ports—the regiment was not reunited until 1797.

While the hurricane was at its height several shocks of earthquake were felt in different parts of England.

LESSER GALES.

Among the gales somewhat lesser in importance, but causing great destruction in times of war, were :—

The storm of November 1559 in the Mediterranean, scattering the fleet of the Duke of Medina Celi off the coast of Sicily when setting out to attack Tripoli; and the terrible storm of Malaga in 1562, when nearly twenty Spanish galleys and several thousand men, preparing for an expedition to the African coast, were dashed to pieces.

In September 1602 Admiral Monson's fleet was, when off the Tagus, dispersed by a gale. The Spanish fleet came out when the wind dropped and nearly cut off one of his vessels. The admiral, in the *Swiftsure*, alone (his other vessels were out of sight) stood down to protect it, and his bold face caused the leading ships of the enemy to wait until reinforced. In the interval both the English vessels succeeded in getting off.

Sir Walter Raleigh's unfortunate expedition in search of the great Plate Fleet set out in 1617. When off the south coast of Ireland it encounted a great gale at midsummer, and had to put back to port for repairs, being delayed thereby at Cork until August. A second tempest smote this fleet off the Cape de Verde Islands.

Admiral Holbourne's fleet was caught off Louisberg, then besieged by us, in September 1757, and most of the ships comprised in it were dismasted and several were blown ashore.

In December 1762 the squadron of Admiral Pocock, returning from the capture of the Havannah, was almost annihilated by a gale off the coast of Ireland. Fourteen vessels were wrecked, most of them lost with all their crews, and others had to throw their guns overboard to lighten the ships.

At a very critical period of the war Admiral Byron's fleet going out to North America encountered a violent gale in July 1778, and on getting across the Atlantic another severe storm off Sandy Hook in October 1778, disabling his vessels.

The gale of December 10, 1796, was badly felt at Gibraltar, H.M.S. *Courageux* was wrecked, H.M.S. *Gibraltar* struck on a rock, and H.M.S. *Culloden* nearly went ashore.

November and December 1811 were wild and stormy months in the Baltic. The 98-gun ship *St. George* was driven ashore in the Belt and dismasted in November. She was, however, got off, repaired, and sent to England in the month following, accompanied by two 74-gun ships. When off the coast of Jutland, a terrible storm again set in on Christmas Eve, and the *St. George* (the flagship of Admiral Reynolds, then second in command in the Baltic) was totally lost, only twelve lives being saved out of a crew of 850 men. The 74-gun ship *Defence* was lost at the same time as her consort.

One closing instance of bad weather shall be given, that of the squally restless winds of the Adriatic in 1809. The Russians and French had ten larger warships and some brigs and gunboats—yet Sir William Hoste with a single frigate and a sloop dominated the Adriatic. In eighteen months the *Amphion* destroyed 218 of the enemy's vessels—yet this was only during a portion of her time on the station. "The fact is," wrote Hoste, "the enemy are afraid of the weather and are badly manned; we are well manned and do not care a rap about the weather." Such was the magnificent result of English naval training during war-time —and which incidentally emphasises the value of preparation and practice in times of peace.

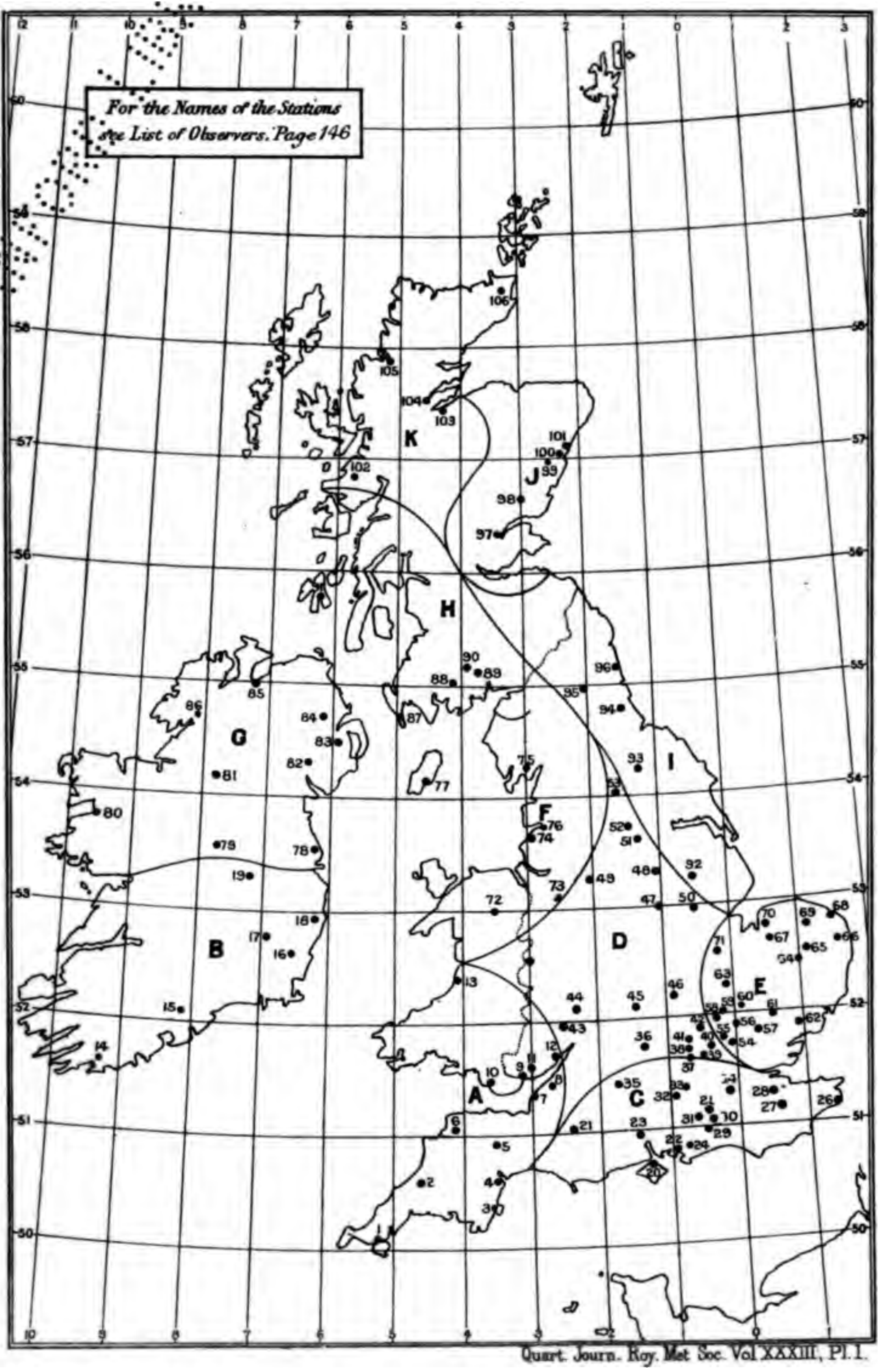
It has been recalled to us to-night how the issue of some of the greatest events in history has been affected by weather, such as the annihilation of the Persian hordes invading Europe, the recoil of the Moslem inroad from the walls of Vienna, the delivery of England from the Catholic hosts of Spain, and the collapse of France under the first Napoleon in Russia.

Rain perhaps has proved the most insidious enemy of the soldier—witness the disaster of Varus, the defeat at Caldiero of no less skilful a commander than Bonaparte, the lost army of Macdonald in Silesia, or the campaign on the Rappahannock—even more than heat. Some pursuits have been stayed by the latter, but how undauntedly, and with what ardour under leaders whom they trusted, have not men faced alike the killing rays of the sun or climbed the mountain snows of India! The obstacles of cold, snow, or ice have also drawn forth the highest qualities of pluck and endurance, whether over the course of centuries in the surmounting of the Alps by entire armies, the crossing of the ice-clad Baltic, or during the horrors of the French retreat from Russia. How noble has been the devotion to duty of the half-frozen, badly fed, badly clothed forces around Sebastopol, or how unflinchingly in 1870-1 the young conscripts endured the sufferings of the winter campaign of Le Mans! (For the happier days of "winter quarters" passed away with the era of Marlborough and Turenne.) Fog, too, has claimed its victims in such heroic leaders of men as Gustavus, King of Sweden, that true knight Sir Philip Sidney, or the right hand of the great Frederick, the doughty warrior Keith, all of whom were cut off in the prime of life by the misadventure of the weather rather than by the more ordinary perils of war. How many lesser lives too have not climate or weather taken toll of on campaign? The column of "killed, wounded, or missing" is not the heaviest total in war—it is the hospital column of disease or illness induced or aggravated by stress of weather.

Now the power of wind has been so largely discounted by steam, and the mariner is released from his fetters, Oversea Invasions—feasible now in hours instead of days—are rendered almost independent of weather, and (unless the place of landing is ill-selected) are both swifter and free of the delays incurred in former years.

In days past the upturned eye found terrors for the superstitious in eclipses, comets, etc., but the time is approaching for the conquest of the air to be attempted, when more real horrors will awe the uplooker, the very heavens themselves will become a new theatre of war, and weather will again assert a fresh influence over the strife of mankind.

MAP SHOWING POSITION OF THE PHENOLOGICAL STATIONS, 1906.


For the Names of the Stations see List of Observers. Page 146
A
B
C
D
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REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR 1906.

By EDWARD MAWLEY, F.R.Met.Soc., V.M.H.

(Plate I.)

[Read February 20, 1907.]

THE following changes have taken place in the observing stations since the last Report was issued. No returns were received during the year from Paignton and St. Davids in District A; Woolton Hill and Weston Green in District C; Beckford and St. Albans (Worley Road) in District D; Brundall in District E; Palé, Manley, Ambleside, and Orry's Dale in District F; Newport, Turriff, and Fordyce in District J; and Roshven in District K. On the other hand, new stations have been started at St. Albans (Glenferrie Road) in District D; Eaton in District E; Llangollen in District F; and Crathes in District J. The total number of observing stations is now 108.

TABLE I.—Mean Results, with their Variations from the 16 Years' Average (1891-1906), for the Thirteen Plants in those Districts where there have been sufficient Observations to warrant Comparisons being made.

Years.	Eng. S.W.		Eng. S.		Eng. Mid.		Eng. E.		Eng. N.W.	
	Day of Year.	Variation from Average.	Day of Year.	Variation from Average.	Day of Year.	Variation from Average.	Day of Year.	Variation from Average.	Day of Year.	Variation from Average.
		Days.		Days.		Days.		Days.		Days.
1891	144	+10	144	+ 9	150	+11	147	+10	150	+ 6
1892	139	+ 5	138	+ 3	144	+ 5	143	+ 6	147	+ 3
1893	118	- 16	122	-13	125	-14	123	-14	128	-16
1894	126	- 8	130	- 5	135	- 4	127	-10	137	- 7
1895	139	+ 5	138	+ 3	141	+ 2	138	+ 1	144	0
1896	125	- 9	128	- 7	132	- 7	130	- 7	134	-10
1897	130	- 4	132	- 3	136	- 3	132	- 5	142	- 2
1898	133	- 1	135	0	138	- 1	136	- 1	141	- 3
1899	136	+ 2	136	+ 1	141	+ 2	138	+ 1	145	+ 1
1900	142	+ 8	141	+ 6	144	+ 5	143	+ 6	152	+ 8
1901	138	+ 4	139	+ 4	141	+ 2	139	+ 2	144	0
1902	139	+ 5	140	+ 5	145	+ 6	142	+ 5	152	+ 8
1903	134	0	134	- 1	137	- 2	134	- 3	145	+ 1
1904	139	+ 5	139	+ 4	142	+ 3	140	+ 3	149	+ 5
1905	133	- 1	135	0	138	- 1	136	- 1	144	0
1906	135	+ 1	134	- 1	138	- 1	137	0	143	- 1
Mean	134	...	135	...	139	...	137	...	144	...

Explanation of the Dates in the Tables.

1- 31 are in January.
32- 59 ,, February.
60- 90 ,, March.
91-120 ,, April.
121-151 ,, May.
152-181 ,, June.
182-212 are in July.
213-243 ,, August.
244-273 ,, September.
274-304 ,, October.
305-334 ,, November.
335-365 ,, December.

The averages with which the mean dates of the different plants are compared in Table IV. have been obtained from the actual observations made during the 16 years 1891-1906 in all those districts where sufficient observations were available. Those for the two remaining districts are as near approximations to the true averages as the limited number of records will allow.

The Winter of 1905-6.

Taken as a whole this was a mild and wet winter with an unusually good record of sunshine. December and January proved warm in all parts of the British Isles, while February was everywhere as unseasonably cold. The rainfall in December was in all districts light, whereas in January and February it was in most places in excess of the average. February proved very sunny for a winter month, but in the other two months of the quarter the duration of bright sunshine was very unequally distributed.

The dry weather in December enabled the farmer to get in any autumn corn left unsown owing to the saturated condition of the ground in the latter half of November. The grain, however, germinated in most cases very slowly, which is generally attributed to the dryness of the soil in October. This was no doubt also due to the coldness of the ground during October and November. Throughout the greater part of January and February the frequent rainfall greatly interrupted the further cultivation of the land. Indeed, at the end of the season very little spring corn had been sown even in the south and east of England. Notwithstanding the exceptionally heavy rains in January and the great mildness of December and January the autumn-sown corn, and particularly the wheat, presented throughout a most promising appearance and was at no time too forward. The only favourable conditions in this otherwise untoward season were the general mildness of the weather, the dryness of the ground at the end of December, which enabled the persistent rains which fell afterwards to percolate readily into the subsoil, and the unusually sunny character of February. Owing to the great mildness of December and January the cattle could be left in the pastures much longer and more frequently than usual, while the roots still left in the fields materially increased in size. The excessive rainfall in January was welcomed, as it served to replenish the ponds and drinking-places, which in many places were dried up.

Owing to the October frosts and the cold weather which followed, there were even fewer flowers than usual to be seen in the gardens during the early part of the season. On the other hand, such early flowering plants as the winter aconite, snowdrop, etc., favoured by the mild winter, came into blossom much in advance of their ordinary time. The green vegetables in the kitchen garden under the same favourable conditions continued to improve, and throughout the season yielded a plentiful supply. During the dry and open weather in December, the planting and transplanting of fruit and other trees could be undertaken under the most suitable conditions, but after that month the ground was mostly too wet to allow of such work being satisfactorily carried out.

The fertile flowers on the hazel, taking the country as a whole, made their appearance 5 days earlier than usual.

The song-thrush was first heard after the beginning of January, 15 days in advance of its average date.

The honey-bee was first seen to visit flowers 1 day early.

The Spring.

Regarded as a whole, this was a cold and bright spring. In all parts of the United Kingdom and in each month of the season the mean temperature was below the average. March and April were in most places dry months, but in May the rainfall was everywhere more or less in excess of the mean. There was a good record of sunshine in March and April, and particularly in April, whereas during May the record was everywhere deficient.

The preparation of the land for the reception of spring corn was fortunately in a very forward condition at the beginning of the season. For, owing to the saturated condition of the soil in March, and the frequent interruptions which took place afterwards, there has seldom been a more trying spring for sowing any grain crop, and more particularly on anything like heavy soil. In the first place, during March the ground was too cold and wet. Then came dry weather in April, which rendered the surface hard and tough. In the early part of May, however, favoured by rain and warmer weather, more progress was possible and a better seed-bed obtained. Throughout the spring the autumn-sown corn, no doubt helped by the sunshine in April, continued to make satisfactory progress. During this cold and dry season the pastures remained unusually bare. At the end of the quarter there came a spell of warmer and wetter weather, which enabled the grass at last to make some growth, but it was then too late to hope for a really good crop of hay.

This was a very unsatisfactory season for seed-sowing in the garden, owing at first to the wetness of the soil, and afterwards to the cold and dry weather in April, which caused the seeds to germinate slowly and irregularly. In May, however, the conditions were more favourable. The fruit-trees flowered abundantly, but nearly the whole of the blossom on the pears and plums was destroyed by the April and May frosts. Very little growth was made during this season, owing to the dry weather and many cold nights.

Until about the middle of April the spring plants on the list flowered earlier than usual, the coltsfoot being 2 days early, the wood anemone 4 days early, the blackthorn 5 days early, and the garlic hedge-mustard 5 days early. On the other hand, the horse-chestnut was 6 days late, and the hawthorn 5 days late.

Of the spring migrants included in the report, the swallow was 1 day late, the cuckoo 4 days late, the nightingale 3 days late, and the fly-catcher 1 day late.

The wasp made its appearance 1 day early, the small white butterfly 3 days early, and the orange-tip butterfly 1 day early.

The Summer.

Taking the three summer months together the weather was on the whole warm and exceptionally dry and sunny. June proved as a rule moderately warm, August very warm everywhere, while in July the temperature was generally in defect of the average. In nearly all districts each month of the season was more or less dry, and in each of those months there was a splendid record of sunshine.

During the greater part of June the weather continued very dry, but towards its close there came in many places a welcome and heavy rain, which, as it was immediately preceded by warmer weather, was of great service to the grass, which from that time made rapid progress, so that the crop of hay was better than could a month previously have been anticipated. The yield varied greatly, but in few places in the southern half of England was it even a good average, while in many it was very poor. In the north of England and in Scotland, where the

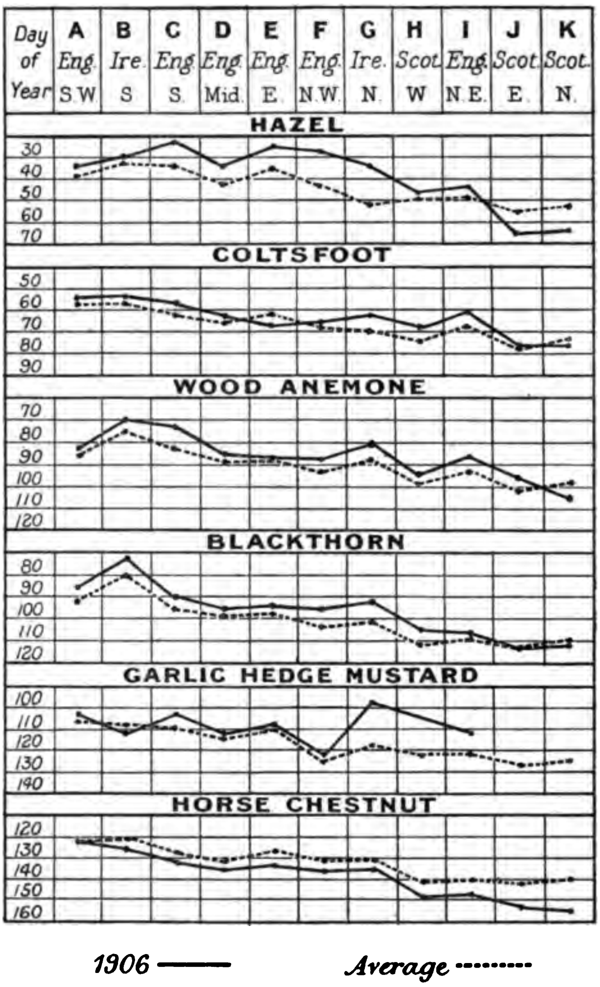


FIG. 1.

rains had been heavier in May, the hay crop was, on the other hand, mostly good. Nearly everywhere the hay harvest was unusually late, but the crop was gathered in very quickly and in excellent condition. The rainfall above referred to was also of considerable help to the corn, which continued to improve. The root crops also benefited for the time, but during the rest of the season made but slow progress, and had in many cases to be re-sown. In the northern counties the conditions were more favourable, and the same may be said of the pastures, which in the south fared badly and were in many places quite burnt up, while in the north the grass remained fresh and green throughout the season.

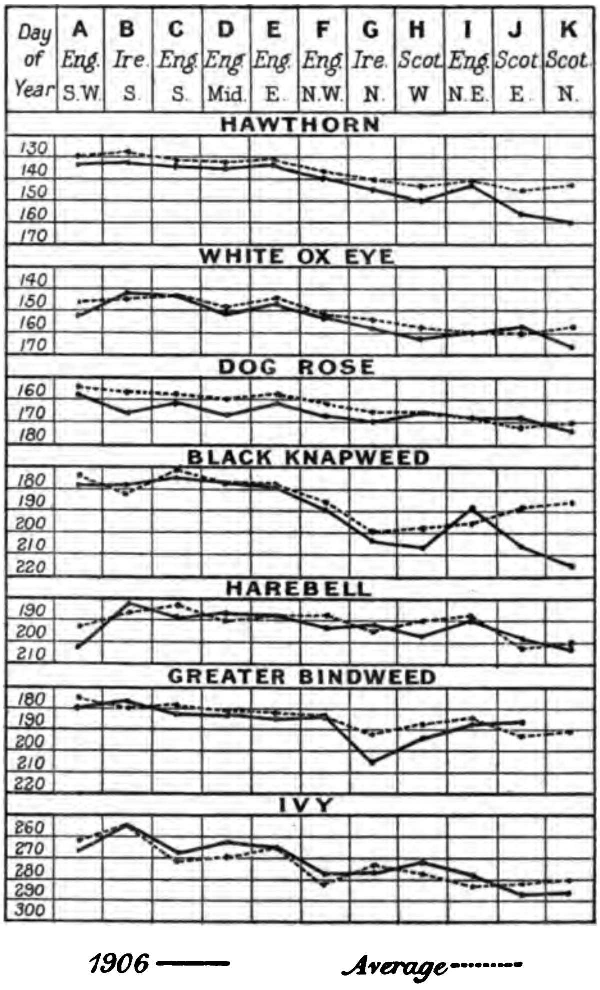


FIG. 2.

During this dry summer the growth made by plants generally was much less than is usual at that season. On the whole, the flower garden continued fairly gay, but in the kitchen garden the progress made was far from satisfactory. On dry soils before the end of the summer many shrubs had begun to show the effects of the drought on them, while throughout a great part of the southern half of England the lawns had become quite brown.

All the summer flowering plants on the list came into blossom behind their usual dates, the white ox-eye being 2 days late, the dog-rose 3 days late, the black knapweed 5 days late, while the harebell and greater bindweed were 2 days late.

The meadow brown butterfly made its appearance 6 days later than usual.

The Autumn.

The most noteworthy features of this autumn were its high mean temperature and the splendid record of sunshine in September. Each of the three months was warm in all parts of the country. September proved everywhere dry, whereas in October and November the rainfall in nearly all districts was in excess of the average. The sun shone for an exceptional number of hours in September, while in October and November the record of sunshine was more or less poor.

Before the harvest month of September had begun much of the corn had been got in in the east and south of England, the grain ripening very rapidly during the last ten days in August. And as the weather continued fine the harvest was soon over and the various corn crops gathered in in splendid condition. Considering the great heat, but little grain was shed. The yield, and especially that of wheat, was remarkably good, and the straw, although shorter than usual, was in other respects all that could be wished. In all but the late districts the harvest had been completed by the end of the third week in September. The long drought, which in the southern, eastern, and midland counties of England may be said to have lasted from the beginning of June until the beginning of October, at last came to an end, and as the ground at the same time became warm, the grass in the pastures which had previously been for many weeks quite burnt up rapidly regained its freshness, while the languishing root crops at once started to grow again. It is seldom so late in the year that vegetation has been known to make such rapid strides in so short a time as was the case at this period. Indeed, the whole aspect of the landscape was suddenly transformed. In all the other districts, where the drought had not been nearly as persistent, the change to moist weather proved also very beneficial. Ploughing the land at once commenced, and many excellent tilths for the sowing of autumn corn and other crops were obtained. So persistent was the rainfall from this period that at times the ground was too saturated, but so dry had the subsoil become that after a few days of drier weather the cultivation of the land and sowing operations could with advantage be resumed. Unlike the previous autumn, the grain germinated quickly. A return to finer weather in the latter half of November allowed potatoes, mangolds, and swedes to be lifted and stored.

Everything in the garden remained nearly at a standstill until the long drought came to an end with September; after which time, the weather being warm, as well as wet, very rapid growth was made, considering the time of year, both in the flower and kitchen garden. The lawns in the early districts, which had for weeks together been burnt up, quickly became fresh and green again.

One of the most noteworthy features of this remarkable season was the unusually long time the trees retained their leaves without change of colour, except in those localities where, owing to the dryness of the soil, they had become yellow prematurely and much of their foliage had been already shed.

The only autumn plant on the list, the ivy, came into flower 1 day in advance of its average date.

Taking the country as a whole, the last swallow took its departure 1 day later than its usual time.

According to the *Preliminary Statement* for Great Britain, issued by the Board of Agriculture, the yield of wheat per acre exceeded the average for the previous ten years by 2·44 bushels, barley by 1·54 bushel, oats by 1·63 bushel, beans by 6·14 bushels, peas by 3·60 bushels, potatoes by 0·28 ton, turnips and swedes by 1·26 ton, mangolds by 1·09 ton, and hay (clover, etc.) by 0·15 cwt. On the other hand, hay (permanent pasture) fell short of the average by 0·98 cwt.

The heavy wheat crop in 1906 again serves to confirm the conclusion at which Dr. Shaw had two years ago arrived, viz., that there was a very close connection between the character of the autumn rainfall and the yield of wheat in the following year. For, as stated in my last report, the autumn of 1905 "was not only a cold but also a dry one." In the numerous farm reports I have consulted for the purposes of this paper, there was, as in the previous year, a very general consensus of opinion that from seed-time to harvest the appearance of the wheat crop never seemed to give any cause for anxiety, although the weather conditions often appeared far from favourable.

Taking the British Isles as a whole, the corn harvest began two days earlier than the average date for the previous seventeen years.

The yield of fruit was variable, apples being a good crop except in the northern counties of England and in Scotland, whereas those of pears and plums were everywhere very poor. All the small fruits were about average.

The Year.

The most noteworthy features of the weather of the phenological year ending November 1906 as affecting vegetation, were the dry period lasting from the beginning of June until the end of September, and the great heat and dryness of the air during the last few days in August and the first few days in September. Wild plants came into flower in advance of their usual dates until about the middle of April, after which time they were, as a rule, to about the same extent late. Such early spring migrants as the swallow, cuckoo, and nightingale reached these islands somewhat behind their average dates. The only deficient farm crop, taking the country as a whole, was that of hay, all the others being more or less over average. The yield of apples was about average in all but the north of England and in Scotland, where there was a very scanty crop. Pears and plums were everywhere very deficient, whereas all the small fruits yielded moderately well. As regards the farm crops the past year proved even a more bountiful one than that of 1905.

TABLE II.—LIST OF THE STATIONS WITH THE NAMES OF THE OBSERVERS.

STATION.	COUNTY.	Height above Sea-level.	OBSERVER.
A		Ft.	
1. Mawnan	Cornwall	200	Miss R. Barclay.
2. Altarnon	Cornwall	600	C. U. Tripp, M.A., F.R.Met.Soc.
3. Brixham	Devon	40	F. W. Millett.
4. Starcross	Devon	50	P. G. Waterfield.
5. Tiverton	Devon	270	Miss M. E. Gill.
6. Barnstaple	Devon	90	T. Wainwright.
7. Sidcot	Somerset	200	W. F. Miller.
8. Clifton	Gloucester	300	G. C. Griffiths, F.E.S.
9. Penarth	Glamorgan	120	G. A. Birkenhead.
10. Bridgend	Glamorgan	90	H. J. Randall, Junr.
11. Little Mill	Monmouth	300	W. J. Grant, F.R.H.S.
12. St. Arvans	Monmouth	360	Miss M. Peake.
13. Aberystwith	Cardigan	30	J. H. Salter, D.Sc.
B			
14. Skibbereen	Cork	30	W. F. Wolfe.
15. Tallow	Waterford	...	Mrs. H. C. Deane.
16. Ferns	Wexford	260	G. E. J. Greene, M.A., D.Sc., F.L.S.
17. Bagenalstown	Carlow	290	Miss F. S. Wynne.
18. Ovoca	Wicklow	110	Miss W. F. Wynne.
19. Geashill	King's County	280	Rev. Canon Russell.
C			
20. Bembridge	Isle of Wight	80	C. Orchard, F.R.H.S.
21. Buckhorn Weston	Dorset	290	Miss H. K. H. D'Aeth.
22. Havant	Hants	30	H. Beeston.
23. Botley	Hants	30	Lady Jenkyns.
24. Birdham	Sussex	10	A. J. Nixon.
25. Muntham	Sussex	250	P. S. Godman, F.Z.S.
26. Dover	Kent	150	F. D. Campbell.
27. Staplehurst	Kent	110	Rev. J. S. Chamberlain.
28. Maidstone	Kent	100	Mrs. Silcock.
29. Chiddingfold	Surrey	230	Admiral Maclear, F.R.Met.Soc.
30. Cranleigh	Surrey	180	Miss H. E. Ravenscroft.
31. Coneyhurst	Surrey	600	J. Russell.
32. Churt Vicarage	Surrey	350	Rev. A. W. Watson.
32. Churt	Surrey	300	C. Criddle.
33. Bagshot	Surrey	230	W. Burgess.
34. Purley	Surrey	350	J. E. Clark, F.R.Met.Soc.
35. Marlborough	Wilts	480	E. Meyrick, F.R.S.
D			
36. Oxford	Oxford	200	F. A. Bellamy, M.A., F.R.A.S.
37. Harefield	Middlesex	340	G. E. Eland.
38. Chesham	Bucks	300	Miss G. Keating.
39. Watford	Herts	270	Mrs. J. Hopkinson.
40. St. Albans (New Farm)	Herts	400	Miss A. Dickinson.
40. St. Albans (Glenferrie Road)	Herts	320	W. P. Westell, F.R.H.S., M.B.O.U.
41. Berkhamsted	Herts	400	Mrs. E. Mawley.
42. Harpenden	Herts	370	J. J. Willis.
43. Ross	Hereford	210	H. Southall, F.R.Met.Soc.
44. West Malvern	Worcester	600	Mrs. Kensington.
45. Farnborough	Warwick	520	Miss D. J. G. Prater.
46. Northampton	Northampton	320	H. N. Dixon, M.A., F.L.S.
47. Beeston	Notts	210	G. Fellows.

TABLE II.—LIST OF THE STATIONS WITH THE NAMES OF OBSERVERS—*continued.*

STATION.	COUNTY.	Height above Sea-level. Ft.	OBSERVER.
48. Hodsock	Notts	60	Miss Mellish, F.R.H.S.
49. Macclesfield	Cheshire	500	J. Dale.
50. Belton	Lincoln	200	Miss F. H. Woolward.
51. Altofts	Yorks (W.R.)	120	H. G. Townsend.
52. Horbury	Yorks (W.R.)	210	W. Rushforth.
53. Ripley	Yorks (W.R.)	240	Rev. W. T. Travis.
E			
54. Broxbourne	Herts	120	Rev. H. P. Waller.
55. Hatfield	Herts	380	Miss R. Blackett.
56. Hertford	Herts	140	W. Graveson.
57. Sawbridgeworth	Herts	350	H. S. Rivers.
58. Hitchin	Herts	220	A. W. Dawson, M.A.
59. Odsey (Ashwell)	Cambridge	260	H. G. Fordham.
60. Shelford	Cambridge	60	C. E. Smith.
61. Bocking	Essex	240	H. S. Tabor, F.R.Met.Soc.
62. Lexden	Essex	90	S. F. Hurnard.
63. Roxton	Beds	...	Miss G. H. Day.
64. Carleton-Forehoe	Norfolk	100	Rev. C. H. Master.
65. Tacolneston	Norfolk	190	Miss E. J. Barrow.
66. Eaton (Norwich)	Norfolk	100	A. W. Preston, F.R.Met.Soc.
67. Southacre	Norfolk	100	Rev. E. T. Daubeney.
68. Brunstead	Norfolk	30	Rev. M. C. H. Bird.
69. Hevingham	Norfolk	...	Major Marsham.
70. Clenchwarton	Norfolk	10	Miss E. M. Stevenson.
71. Peterborough	Northampton	30	J. W. Bodger.
F			
72. Llangollen	Merioneth	270	T. Ruddy.
73. Betley	Stafford	250	Miss M. L. Hodgson.
74. Birkdale (Southp't)	Lancashire	40	E. J. B. Sopp.
75. Preston	Lancashire	50	J. R. Charnley, F.G.S., F.Z.S.
76. Lake Side	Lancashire	210	Miss L. Burton.
77. Cronkbourne	Isle of Man	110	A. W. Moore and J. Murphy.
G			
78. Ardgillan	Dublin	210	J. Woodward.
79. Edgeworthstown	Longford	270	J. M. Wilson, M.A.
80. Westport	Mayo	10	J. M. McBride.
81. Chanter Hill	Fermanagh	250	The Dean of Clogher.
82. Loughbrickland	Down	350	Rev. Canon Lett.
83. Saintfield	Down	310	Rev. C. H. Waddell, M.A.
84. Antrim	Antrim	70	Rev. W. S. Smith.
85. Altnafoyle	Londonderry	450	T. Gibson.
86. Milford	Donegal	150	Miss Osborne.
H			
87. Kirkmaiden	Wigtown	100	Rev. D. R. Williamson.
88. New Galloway	Kirkcudbright	450	T. R. Bruce.
89. Jardington	Dumfries	100	J. Rutherford.
90. Moniaive	Dumfries	350	J. Corrie.
91. Port Ellen	Isle of Islay	10	T. F. Gilmour.
I			
92. Doddington	Lincoln	90	Rev. R. E. Cole.
93. Thirsk	Yorks (N.R.)	120	A. B. Hall.
94. Durham	Durham	350	Prof. R. A. Sampson and F. C. H. Carpenter.

TABLE II.—List of the Stations with the Names of Observers—*continued.*

Station.	County.	Height above Sea-level.	Observer.
		Ft.	
95. Corbridge-on-Tyne	Northumberland	200	A. W. Price.
96. Blyth . .	Northumberland	20	S. Dunnett.
J			
97. Forgandenny .	Perth . .	...	D. Nicoll.
98. Kirriemuir .	Forfar . .	250	T. M. Nicoll.
99. Durris . .	Kincardine .	420	A. Macdonald, M.A.
100. Crathes . .	Kincardine .	140	J. Smith, F.R.Met.Soc.
101. Aberdeen . .	Aberdeen .	40	P. Harper.
K			
102. Invermoidart .	Inverness . .	60	S. M. Macvicar.
103. Beauly . .	Inverness. .	60	A. Birnie.
104. Dingwall . .	Ross . .	10	J. P. Smith, M.D.
105. Inverbroom .	Ross . .	50	Lady Fowler.
106. Watten . .	Caithness. .	150	Rev. D. Lillie.

The numbers before the names of the stations refer to their position on the Map of the Stations. Plate I.

Observers' Notes.

December 1905.—*Mawnan* (A)—21st. Pink campion in flower. *Aberystwith* (A)—3rd. Pyrus japonica in flower. 7th. Small bat seen. *Havant* (C)—8th. The date for the last swallow is a remarkably late one. *Churt Vicarage* (C)—25th. Among other flowers out on Christmas day in my garden were China roses, laurestinus, snowdrops, and primroses. *Bagshot* (C)—Fewer holly berries than I have ever seen here. *Purley* (C)—24th. Found wild primrose in flower; 33 wild flowers noted in the neighbourhood of Croydon between 23rd and 31st. *Berkhamsted* (D)—10th. The last rose bloom of the year in my garden destroyed by frost and fog—about an average date for the past 20 years. *Brunstead* (E)—31st. Mignonette still in flower. *Betley* (F)—20th. The cattle still in the fields, later than for many years. *Antrim* (G)—1st. Bats seen. *Thirsk* (I)—27th. A fully expanded cowslip was found growing well in lane near here. During my twenty years' observations I have no previous record of the cowslip earlier than April.

January 1906.—*Mawnan* (A)—1st. Counted 22 kinds of wild flowers, including primroses. *Ovoca* (B)—19th. A crimson rhododendron in flower without injury from frost since December 19th. *Bembridge* (C)—28th. Prunus pissardi in flower. *Cranleigh* (C)—28th. Pipestrelle bat seen. *Bagshot* (C)—26th. Open flowers on crocuses and snowdrops. *Berkhamsted* (D)—7th. Winter aconite in flower, 12 days earlier than its average date for the previous 17 years. *Beeston* (D)—8th. Ponds and drinking-places filling up nicely. *Hodsock* (D)—10th. Grasses green as in April. *Macclesfield* (D)—The frost of the 27th did much damage to the young leaves and fruit blossom. *Betley* (F)—28th. Rooks building. *Birkdale* (*Southport*) (F)—7th. Great tit first heard. *Cronkbourne* (F)—Rhododendrons in flower till end of month. *Edgeworthstown* (G)—26th.

TABLE III.—DATE (DAY OF YEAR) OF FIRST FLOWERING OF PLANTS, 1906.

STATION.	Hazel.	Coltsfoot.	Wood Anemone.	Blackthorn.	Garlic Hedge-Mustard.	Horse-Chestnut.	Hawthorn.	White Ox-Eye.	Dog Rose.	Black Knapweed.	Harebell.	Greater Bind-weed.	Ivy.
A													
Mawnan	31	62	...	68	...	120	129	162	...	189	...	...	257
Altarnon	59	62	97	104	116	130	150	164	165	196	207	211	*236*
Brixham	59	*83*	...	72	...	111	130	155	164	...	...	186	266
Starcross	26	48	...	75	106	118	116	154	148	161	...	162	259
Tiverton	34	37	79	87	104	127	*106*	149	157	...	...	...	281
Barnstaple	27	47	94	90	96	119	130	153	153	180	196	200	266
Sidcot	20	52	82	92	97	118	136	...	...	...	...	...	...
Clifton	...	...	...	100	...	119	134	...	...	...	...	...	271
Bridgend	52	63	77	101	110	129	141	154	166	175	209	...	273
Little Mill	20	44	71	73	103	109	131	132	147	...	...	...	...
St. Arvans	19	67	78	98	110	125	137	...	...	...	...	...	...
Aberystwith	24	56	78	69	98	130	132	139	161	175	199	191	255
B													
Skibbereen	48	63	*49*	63	...	*144*	138	140	169	...	...	...	...
Tallow	34	58	71	60	...	120	123	143	...	194	...	186	253
Ferns	23	66	*100*	73	...	126	130	147	162	171	181	211	249
Ovoca	5	28	64	76	...	130	139	136	161	187	...	188	264
Geashill	38	56	75	83	112	...	...	...	171	163	...	168	...
C													
Bembridge	23	48	...	84	105	109	118	130	...	...	...	...	...
Buckhorn Weston	27	52	77	89	100	132	127	141	161	172	...	182	257
Havant	12	74	67	91	90	132	140	143	164	171	195	207	271
Botley	13	*88*	75	66	104	138	132	144	163	174	...	195	268
Birdham	43	...	...	77	114	125	...	152	161	...	...	...	...
Muntham	35	44	...	90	...	129	132	143	155	...	...	...	282
Dover	...	61	...	95	...	130	143	...	165	173	...	...	278
Staplehurst	29	64	69	93	*85*	*116*	*118*	137	163	...	183	177	...
Maidstone	14	26	76	104	107	128	128	139	...	170	195	187	262
Chiddingfold	12	59	69	89	107	133	135	143	159	173	*211*	200	263
Cranleigh	29	58	65	94	108	130	131	142	...	...	...	...	268
Coneyhurst	28	67	73	99	...	137	141	151	154	181	181	188	274
Churt Vicarage	22	82	82	102	107	136	136	146	162	176	179	196	...
Churt	8	74	71	96	108	128	130	*129*	*127*	...	...	...	...
Bagshot	13	...	...	...	...	...	...	...	...	...	...	...	...
Purley	32	51	74	76	102	142	131	146	159	188	205	...	...
Marlborough	10	58	70	89	102	139	137	134	161	176	189	192	254
D													
Oxford	...	84	92	98	96	128	129	140	170	...	...	...	...
Harefield	...	63	77	100	124	140	134	151	163	178	195	208	...
Chesham	36	57	75	97	116	141	136	137	...	*199*	...	201	263
Watford	24	66	91	94	100	129	134	137	160	167	181	191	257
St. Albans (New Farm)	17	65	89	81	96	127	133	...	158	...	174	...	272
St. Albans (Glenferrie Road)	...	63	91	97	98	146	133	146	174	...	*230*	180	...
Berkhamsted	46	47	96	101	105	144	145	150	158	182	...	189	273
Harpenden	31	62	95	98	103	129	133	159	162	173	...	...	...

TABLE III.—DATE (DAY OF YEAR) OF FIRST FLOWERING OF PLANTS, 1906—*continued.*

STATION.	Hazel.	Coltsfoot.	Wood Anemone.	Blackthorn.	Garlic Hedge-Mustard.	Horse-Chestnut.	Hawthorn.	White Ox-Eye.	Dog Rose.	Black Knapweed.	Harebell.	Greater Bindweed.	Ivy.
Ross	27	64	76	77	*83*	126	123	...	...	...	...	...	...
West Malvern	37	41	61	95	94	122	122	...	...	168	187	189	*225*
Farnborough	28	...	...	99	108	134	134	147	160	*192*	200	211	262
Northampton	53	63	71	100	109	128	135	157	164	172	...	193	248
Beeston	46	65	...	101	125	134	141	164	167	186	*159*	...	...
Hodsock	29	68	77	88	105	129	134	158	166	186	189	181	263
Macclesfield	51	83	114	108	145	146	147	164	172	184	187	189	...
Belton	45	62	83	84	126	134	133	150	...	...	...	...	...
Altofts	27	33	*118*	*122*	124	139	135	160	185	*191*	*232*	*236*	258
Horbury	36	62	87	...	117	136	137	...	...	188	195	204	...
Ripley	17	63	91	104	125	147	147	...	...	...	...	...	...
E													
Broxbourne	*67*	77	75	105	106	...	...	130	164	...	...	...	...
Hatfield	21	68	80	87	...	123	122	150	159	...	191	...	...
Hertford	28	56	63	88	102	133	129	136	158	175	195	194	263
Sawbridgeworth	...	65	95	103	115	141	143	156	...	...	...	193	272
Hitchin	25	67	...	84	102	132	130	151	...	...	...	...	...
Odsey (Ashwell)	16	...	...	...	...	...	...	...	...	...	...	...	...
Shelford	39	*99*	91	79	104	*99*	*108*	141	149	...	186	...	252
Bocking	18	75	99	100	109	135	128	159	161	185	198	200	262
Lexden	28	...	96	99	108	129	129	144	162	...	183	180	267
Roxton	19	61	76	94	113	133	135	141	...	...	...	...	...
Carleton-Forehoe	17	75	93	101	106	141	142	146	...	174	*214*	...	259
Tacolneston	27	63	99	101	101	117	126	...	160	187	...	...	...
Eaton	...	...	93	...	105	128	137	...	168	...	...	195	...
Southacre	18	62	83	95	115	138	137	154	165	173	173	186	267
Brunstead	16	68	...	100	105	138	141	152	165	*205*	194	202	268
Hevingham	...	...	77	...	...	...	142	...	...	...	...	...	...
Clenchwarton	...	66	...	85	*88*	143	137	...	165	...	...	...	268
Peterborough	58	73	87	92	121	128	136	151	158	181	186	192	259
F													
Langollen	48	48	87	97	105	126	132	149	159	195	188	188	271
Betley	8	62	77	89	130	142	135	145	167	183	193	198	291
Birkdale (Southp'rt)	...	73	...	*115*	137	135	140	157	169	193	194	200	280
Lake Side	29	80	81	99	115	140	147	160	161	189	199	188	270
Cronkbourne	...	64	102	...	121	132	145	160	180	...	...	*226*	281
G													
Ardgillan	32	59	81	87	...	127	146	153	170	*216*	...	222	279
Edgeworthstown	...	*102*	...	99	...	...	...	...	...	...	...	...	...
Westport	31	...	62	83	...	117	132	...	166	...	...	...	272
Chanter Hill	31	55	83	72	97	147	147	160	172	193	192	216	277
Loughbrickland	32	*95*	97	105	...	139	144	...	171	...	...	...	...
Saintfield	...	61	79	90	...	135	146	...	164	...	...	...	...
Antrim	30	...	...	97	100	147	150	163	168	200	...	209	271
Altnafoyle	41	55	...	106	...	136	146	...	169	213	...	...	...
Milford	38	79	76	91	...	126	148	159	179	207	...	226	288

TABLE III.—DATE (DAY OF YEAR) OF FIRST FLOWERING OF PLANTS, 1906—*continued.*

STATION.	Hazel.	Coltsfoot.	Wood Anemone.	Blackthorn.	Garlic Hedge-Mustard.	Horse-Chestnut.	Hawthorn.	White Ox-Eye.	Dog Rose.	Black Knapweed.	Harebell.	Greater Bind-weed.	Ivy.
H													
Kirkmaiden	48	39	92	115	...	148	151	166	168	...	209	191	271
New Galloway	27	80	101	...	...	153	...	168	168	209	202	...	...
Jardington	...	83	90	103	...	149	152	159	158	201	181	...	...
Moniaive	*75*	79	94	110	...	149	154	154	168	204	198	218	...
Port Ellen	62	65	*115*	94	...	148	143	...	...	...	...	...	...
I													
Doddington	59	65	94	103	115	138	135	155	165	184	193	...	...
Thirsk	28	51	94	99	107	147	136	156	168	179	186	198	279
Durham	...	67	...	112	...	155	147	...	...	...	...	...	...
Corbridge-on-Tyne	...	76	...	115	...	150	149	163	173	209	194	...	...
Blyth	41	43	69	101	...	143	148	166	171	183	188	...	...
J													
Forgandenny	...	89	...	...	...	156	159	...	...	...	...	...	...
Kirriemuir	...	76	...	108	...	...	154	...	171	206	...	...	...
Durris	64	62	82	114	...	150	158	162	168	204	210	...	287
Crathes	69	*33*	90	114	*154*	154	155	155	168	204	184	197	...
Aberdeen	...	79	115	...	...	...	...	...	...	...	204	...	...
K													
Invermoidart	...	...	101	...	...	...	152	...	...	219	...	...	...
Beauly	58	*110*	123	130	...	163	167	173	174	201	196	...	286
Dingwall	70	85	96	100	...	147	157	161	174	...	213	...	*314*
Inverbroom	*8*	54	102	107	...	157	...	...	174	...	...	...	...
Watten	...	90	...	...	...	...	166	*193*	...	222	...	...	...

The dates in *italics* have not been taken into consideration when calculating the means given in Table IV.

Primroses in bloom. *Chanter Hill* (G)—1st. A nest of young thrushes found. *Antrim* (G)—A rhododendron in flower latter part of month.

FEBRUARY.—*Mawnan* (A)—4th. Several kinds of rhododendrons in flower. 20th. Peach-tree in bloom. *Altarnon* (A)—At end of month farmers and gardeners were wanting dry weather. 21st. Frog spawn first seen. *Tiverton* (A)—Violets and primroses have been in flower all the winter in the garden. *Churt Vicarage* (C)—23rd. Considerable damage to trees by heavy fall of snow. *Farnborough* (D)—Penstemons have for the first time survived the winter with me. *Odsey* (*Ashwell*) (E)—21st. Rooks building. *Clenchwarton* (E)—1st. Some roses in full bloom in the open. *Betley* (F)—28th. Pear-trees nearly in flower. *Birkdale* (*Southport*) (F)—Wallflowers in bloom all the winter.

MARCH.—*Mawnan* (A)—27th. Last summer's mignonette still in flower. *Harefield* (D)—6th. Bats first seen. *Berkhamsted* (D)—An early Rivers peach on a south wall in blossom, 17 days earlier than its average date in the previous

TABLE IV.—MEAN DATES (DAY OF YEAR) FOR THE FIRST FLOWERING OF 13 PLANTS IN 1906, AND THEIR VARIATIONS FROM THE 16 YEARS' AVERAGE, 1891-1906.

PLANTS.	A England, S.W.			B Ireland, S.			C England, S.			D England, Mid.		
	1906.	Average for 16 Years.	Variation from Average.	1906.	Average for 16 Years.	Variation from Average.	1906.	Average for 16 Years.	Variation from Average.	1906.	Average for 16 Years.	Variation from Average.
Hazel	34	39	– 5	30	31	– 1	22	34	– 12	34	42	– 8
Coltsfoot . . .	54	56	– 2	54	55	– 1	58	62	– 4	62	64	– 2
Wood Anemone . .	82	85	– 3	70	74	– 4	72	83	– 11	85	88	– 3
Blackthorn . . .	86	91	– 5	71	80	– 9	90	96	– 6	95	99	– 4
Garlic Hedge-Mustard	104	106	– 2	112	110	+ 2	104	110	– 6	112	114	– 2
Horse-Chestnut . .	121	121	0	125	121	+ 4	131	127	+ 4	135	131	+ 4
Hawthorn . . .	133	130	+ 3	132	128	+ 4	133	132	+ 1	135	134	+ 1
White Ox-Eye . .	151	146	+ 5	141	143	– 2	142	142	0	151	149	+ 2
Dog Rose . . .	158	155	+ 3	166	157	+ 9	161	158	+ 3	166	160	+ 6
Black Knapweed .	179	174	+ 5	179	181	– 2	175	172	+ 3	178	178	0
Harebell . . .	203	194	+ 9	181	*186*	– 5	190	184	+ 6	188	190	– 2
Greater Bindweed .	190	185	+ 5	188	190	– 2	192	189	+ 3	194	192	+ 2
Ivy	266	263	+ 3	255	255	0	268	271	– 3	262	270	– 8
Mean for the 13 Plants	135	134	+ 1	131	132	– 1	134	135	– 1	138	139	– 1

PLANTS.	E England, E.			F England, N.W.			G Ireland, N.			H Scotland, W.		
Hazel	25	35	– 10	28	43	– 15	34	51	– 17	46	49	– 3
Coltsfoot . . .	67	62	+ 5	65	66	– 1	62	70	– 8	69	74	– 5
Wood Anemone . .	86	87	– 1	87	93	– 6	80	86	– 6	94	99	– 5
Blackthorn . . .	94	97	– 3	95	104	– 9	92	101	– 9	105	112	– 7
Garlic Hedge-Mustard	108	110	– 2	122	124	– 2	98	*119*	– 21	...	*122*	...
Horse-Chestnut . .	133	126	+ 7	135	132	+ 3	134	131	+ 3	149	141	+ 8
Hawthorn . . .	134	131	+ 3	140	138	+ 2	145	140	+ 5	150	144	+ 6
White Ox-Eye . .	147	146	+ 1	154	153	+ 1	159	155	+ 4	162	159	+ 3
Dog Rose . . .	161	157	+ 4	167	162	+ 5	170	165	+ 5	165	165	0
Black Knapweed .	179	179	0	190	188	+ 2	203	200	+ 3	205	199	+ 6
Harebell . . .	188	188	0	193	188	+ 5	192	*194*	– 2	197	190	+ 7
Greater Bindweed .	193	192	+ 1	193	193	0	216	202	+ 14	204	*198*	+ 6
Ivy	264	264	0	279	281	– 2	277	276	+ 1	271	*277*	– 6
Mean for the 13 Plants	137	136	+ 1	142	143	– 1	143	145	– 2	151*	151*	0*

PLANTS.	I England, N.E.			J Scotland, E.			K Scotland, N.			British Isles.		
Hazel	43	49	– 6	66	*55*	+ 11	64	*53*	+ 11	39	44	– 5
Coltsfoot . . .	60	67	– 7	76	*77*	– 1	76	*75*	+ 1	64	66	– 2
Wood Anemone . .	86	93	– 7	96	*101*	– 5	105	*99*	+ 6	86	90	– 4
Blackthorn . . .	106	108	– 2	112	*112*	0	112	*110*	+ 2	96	101	– 5
Garlic Hedge-Mustard	111	121	– 10	...	*127*	...	...	*125*	...	109	114	– 5
Horse-Chestnut . .	147	140	+ 7	153	*142*	+ 11	156	*140*	+ 16	138	132	+ 6
Hawthorn . . .	143	142	+ 1	156	*146*	+ 10	160	*144*	+ 16	142	137	+ 5
White Ox-Eye . .	160	160	0	158	*160*	– 2	167	*158*	+ 9	154	152	+ 2
Dog Rose . . .	169	169	0	169	*172*	– 3	174	*170*	+ 4	166	163	+ 3
Black Knapweed .	189	195	– 6	205	*189*	+ 16	214	*187*	+ 27	191	186	+ 5
Harebell . . .	190	189	+ 1	199	*202*	– 3	204	*200*	+ 4	193	191	+ 2
Greater Bindweed .	198	197	+ 1	197	*203*	– 6	...	*201*	...	196	194	+ 2
Ivy	279	282	– 3	287	*282*	+ 5	286	*280*	+ 6	272	273	– 1
Mean for the 13 Plants	145	147	– 2	156*	*153**	+ 3*	156†	*147*†	+ 9†	168	168	0

* For 12 Plants. † For 11 Plants.

+ indicates the number of days later than the average date.
– ,, ,, ,, earlier ,, ,,
o ,, average date (1891-1906).
The dates in *italics* are approximate averages.

20 years. *Harpenden* (D)—17th. Frog spawn first seen. *Ripley* (D)—29th. Song-thrush's nest with eggs. *Betley* (F)—Much damage done to early flowering pears, damsons, and plums. *Birkdale* (*Southport*) (F)—3rd. Frog spawn first seen. *Lake Side* (F)—21st. Water wagtail first seen.

APRIL.—*Altarnon* (A)—14th. Wryneck first heard. 20th. Fine show of fruit blossom. *Bridgend* (A)—3rd. Wheatear first seen. *St. Arvans* (A)—11th. Willow-wren. 26th. Potatoes blackened by frost. *Skibbereen* (B)—Potatoes cut by frost. *Botley* (C)—14th. Chaffinch. *Chiddingfold* (C)—28th. The whole of the plum blossom destroyed by frost. *Cranleigh* (C)—10th. Wryneck first heard. *Coneyhurst* (C)—10th. Sand-martin first seen. Oaks exceptionally free from caterpillars this year. *Churt Vicarage* (C)—6th. Wryneck first heard. A very backward spring, owing to the cold and drought of this month. *Oxford* (D)—The growth of every plant seemed stationary owing to keen winds and no rain between the 6th and 30th. 27th. Wild cherry in flower. *Harefield* (D)—7th. Wryneck first heard. *St. Albans* (*New Farm*) (D)—25th. Buds on walnut and horse-chestnut blackened by frost. *Berkhamsted* (D)—10th. A wild cherry tree in my garden came into flower, 9 days in advance of its average date in the previous 20 years. *Beeston* (D)—Vegetation at a standstill owing to cold and frosty nights. 16th. Willow-wren. *Hodsock* (D)—13th. Wild cherry in flower. *Ripley* (D)—11th. Sand-martin first seen. *Tacolneston* (E)—11th. Wryneck first heard. *Jardington* (H)—11th. Sand-martin first seen. *Moniaive* (H)—8th. Wheatear seen. 17th. Sand-piper. *Durris* (J)—13th. Sand-martins first seen.

MAY.—*Mawnan* (A)—Slight frost spoilt the setting of the pears. *Altarnon* (A)—19th. Frost damaged potatoes. *St. Arvans* (A)—18th. Apple-trees very full of blossom. *Ovoca* (B)—Abundant blossom on hawthorn, laburnums, and most of other flowering shrubs. *Churt Vicarage* (C)—19th. Potatoes cut by frost. 22nd. The blossom on pears and apples exceptionally abundant. 28th. First swarm of bees. *St. Albans* (*Glenferrie Road*) (D)—Although a wealth of buds on lilacs, they never opened. *Berkhamsted* (D)—5th. A Blenheim orange apple in my garden came into blossom 1 day earlier than its average date in the previous 20 years. *Hodsock* (D)—18th. Young leaves of ash blackened by frost. *Hitchin* (E)—Many of the buds on the horse-chestnuts were destroyed by frost just before blossoming. *Bocking* (E)—Apple blossom abundant, but other fruit-trees are flowering sparingly. *Clenchwarton* (E)—17th. Water-wagtail first seen. *Birkdale* (*Southport*) (F)—Laburnum, lilac, gorse, and hawthorn blossom abundant. *Cronkbourne* (F)—22nd. Tender plants blackened by frost. *Chanter Hill* (G)—Nothing grew between 12th and 25th. *Antrim* (G)—In the middle of the month the foliage on the windward side of hedges was shrivelled by cold winds and frost, and afterwards turned brown over a large tract of country. *Altnafoyle* (G)—12th. Willow-wren. *Corbridge-on-Tyne* (I)—13th. Sand-martin first seen.

JUNE.—*Mawnan* (A)—20th. Hay first cut. *Churt Vicarage* (C)—5th. French beans in lower part of parish injured by frost. Butterflies less numerous than usual. *Harefield* (D)—3rd. Nightjar first heard. 16th. Hay first cut. *St. Albans* (*Glenferrie Road*) (D)—12th. Hay first cut. *Harpenden* (D)—1st. Heavy thunderstorm, 2 oak-trees struck by lightning. Hailstones like little balls of snow and as large as hazel-nuts. 18th. Potatoes cut down by frost. 20th. First wheat-ear out of its sheath. *Tacolneston* (E)—10th. Have never seen so few chimney-swallows and house-martins as there are here this year. 15th. Beans only about half their usual height. *Betley* (F)—29th. Cuckoo last heard. *Birkdale* (*Southport*) (F)—19th. Hay first cut. Very few swallows. *Cronkbourne* (F)—20th. First hay cut. *Westport* (G)—Cuckoos very numerous. *Jardington* (H)—Fruit blossom very abundant. *Moniaive* (H)—30th. Hay harvest began. *Thirsk* (I)—27th. Haymaking began.

TABLE V.—DATE (DAY OF YEAR) OF SONG AND MIGRATION OF BIRDS, AND FIRST APPEARANCE OF INSECTS, 1906.

STATION.	Song.	Migration.					Insects.				
	Song-Thrush first heard.	Swallow first seen.	Cuckoo first heard.	Nightingale first heard.	Flycatcher first seen.	Swallow last seen.	Honey Bee.	Wasp.	Small White Butterfly.	Orange Tip Butterfly.	Meadow Brown Butterfly.
A											
Mawnan	1	108	102	...	...	290	...	128	97	134	181
Altarnon	2	103	106	...	130	292	62	75	98	133	160
Brixham	2	*124*	112	...	...	288	89	...	92	135	188
Starcross	3	107	115	...	*151*	297	29	96	100	132	154
Tiverton	...	...	...	...	...	...	38	...	...	...	...
Sidcot	...	102	105	132	...	...	62	...	100	...	...
Clifton	...	*124*	*125*	124	...	...	...	...	103	...	...
Penarth	...	...	...	...	...	...	*103*	104	98	133	181
Bridgend	3	95	124	...	...	280	66	...	114	133	...
Little Mill	13	106	111	130	131	...	26	72	78	96	128
St. Arvans	14	104	106	...	126	...	26	131	102	134	...
Aberystwith	5	96	121	...	134	281	...	102	99	101	165
B											
Skibbereen	6	96	*125*	...	146	315	58	111	91	96	173
Tallow	...	...	101	...	...	277	76	90	*122*	128	140
Ferns	2	100	115	...	...	300	62	103	100	102	136
Bagenalstown	2	...	...	...	...	...	...	...	...	...	...
Ovoca	2	104	120	...	...	285	77	87	99	107	127
Geashill	...	97	...	...	...	283	52	...	...	...	...
C											
Bembridge	2	96	96	102	...	...	62	...	104	132	180
Buckhorn Weston	3	108	102	...	132	...	62	110	97	103	170
Havant	1	96	99	105	132	355	51	67	93	112	184
Botley	2	95	106	120	120	292	26	66	97	129	169
Birdham	7	85	100	100	...	314	17	...	...	...	...
Muntham	7	106	103	106	117	291	...	*9*	*130*	139	...
Dover	...	111	...	...	...	311	...	...	...	...	...
Staplehurst	*58*	91	91	114	124	...	49	61	*65*	115	183
Maidstone	5	106	113	111	125	278	63	...	96	...	...
Chiddingfold	1	101	101	103	132	274	...	96	101	127	184
Cranleigh	3	103	95	100	144	279	63	...	100	*143*	...
Coneyhurst	*40*	102	102	106	*150*	276	62	86	90	...	...
Churt Vicarage	12	103	107	108	132	288	57	94	101	117	171
Churt	4	100	103	106	127	...	18	69	107	131	...
Bagshot	12	...	...	...	...	...	52	...	...	...	...
Purley	5	...	122	114	...	282	63	...	112	133	174
Marlborough	27	106	114	120	*105*	...	51	...	97	127	170
D											
Oxford	1	*124*	117	119	...	...	...	...	...	...	...
Harefield	...	107	107	106	...	273	...	...	103	...	...
Chesham	...	102	108	122	...	288	27	104	100	128	...
Watford	...	96	104	...	...	280	52	101	102	130	...
St. Albans (New Farm)	4	113	105	111	135	288	52	...	95	117	171
St. Albans (Glenferrie Road)	2	...	...	...	146	...	*91*	127	96	133	...
Berkhamsted	7	96	116	105	*151*	296	52	93	97	132	...
Harpenden	7	107	107	120	...	...	63	132	*128*	133	...
Ross	2	106	114	124	133	...	52	75	105	106	...
West Malvern	3	106	103	114	131	286	66	94	116	123	...
Farnborough	4	102	100	*133*	129	282	27	134	103	129	...

TABLE V.—DATE (DAY OF YEAR) OF SONG AND MIGRATION OF BIRDS, AND FIRST APPEARANCE OF INSECTS, 1906—*continued.*

STATION.	Song.	Migration.					Insects.				
	Song-Thrush first heard.	Swallow first seen.	Cuckoo first heard.	Nightingale first heard.	Flycatcher first seen.	Swallow last seen.	Honey Bee.	Wasp.	Small White Butterfly.	Orange Tip Butterfly.	Meadow Brown Butterfly.
Beeston	...	108	117	..	137	277	65	94	102	...	...
Hodsock	...	109	120	123	134	294	27	...	...	132	...
Macclesfield	37	135	144	...	...	...	102	104	103	...	...
Belton	3	110	112	119	134	...	63	65	*132*	133	...
Altofts	7	118	125	...	...	293	*100*	...	65	...	...
Ripley	22	103	125	...	136	*264*	*95*	135	100	...	...
E											
Broxbourne	15	105	101	123	132	286	32	130	...	138	138
Hatfield	10	100	105	104	123	278	...	122	123	...	...
Sawbridgeworth	4	104	119	113	129	293	27	97	101	132	...
Hitchin	1	110	116	118	...	...	...	...	...	...	...
Odsey (Ashwell)	...	107	121	*132*	133	286	...	...	...	...	...
Shelford	*33*	100	104	103	...	...	22	66	66	121	163
Bocking	...	...	116	113	...	...	...	...	...	...	...
Lexden	11	107	111	113	133	274	63	94	106	107	172
Roxton	2	102	114	...	141	...	62	...	...	...	...
Carleton-Forehoe	8	108	117	*135*	130	301	26	102	117	130	...
Tacolneston	...	*124*	119	...	...	...	...	...	...	124	...
Southacre	4	110	124	122	135	275	63	76	105	127	168
Brunstead	4	106	108	...	132	290	27	32	95	148	172
Hevingham	...	108	119	...	...	...	...	...	...	...	...
Clenchwarton	4	115	125	...	...	272	33	34	67	97	...
Peterborough	1	108	108	124	137	316	63	...	93	144	...
F											
Llangollen	18	103	121	...	136	277	*92*	103	104	135	...
Betley	4	109	126	...	*110*	302	62	109	101	154	*199*
Birkdale (Southport)	9	127	132	...	145	279	62	82	126	153	181
Preston	29	105	115	...	...	...	50	97	97	...	...
Lake Side	...	126	129	...	...	...	69	...	132	140	...
Cronkbourne	25	105	129	...	...	277	*8*	107	...	...	...
G											
Ardgillan	4	105	120	...	139	291	27	27	127	127	167
Edgeworthstown	...	96	121	...	...	...	96	...	...	...	...
Westport	3	98	121	...	...	270	...	...	...	...	...
Chanter Hill	3	98	125	...	...	270	89	119	130	132	132
Loughbrickland	...	103	129	...	...	274	...	...	101	109	...
Saintfield	1	122	125	...	136	271	...	...	102	132	173
Antrim	...	105	125	...	147	274	*104*	138	101	...	...
Altnafoyle	27	130	128	...	...	...	91	130	132	136	184
Milford	...	105	127	...	...	271	48	96	122	124	166
H											
Kirkmaiden	15	102	125	...	...	283	85	122	...	135	...
New Galloway	*49*	124	124	...	...	270	48	129	124	...	...
Jardington	27	106	111	...	137	278	...	132	100	...	185
Moniaive	5	112	126	...	136	...	...	...	112	...	...
Port Ellen	29	104	123	...	...	...	*1*	...	...	...	...

TABLE V.—Date (Day of Year) of Song and Migration of Birds, and First Appearance of Insects, 1906—*continued.*

Station.	Song.	Migration.					Insects.				
	Song-Thrush first heard.	Swallow first seen.	Cuckoo first heard.	Nightingale first heard.	Flycatcher first seen.	Swallow last seen.	Honey Bee.	Wasp.	Small White Butterfly.	Orange Tip Butterfly.	Meadow Brown Butterfly.
I											
Thirsk	10	97	131	...	...	290	49	...	100	133	151
Durham	*50*	111	130	...	134	273	...	158	102	...	...
Corbridge-on-Tyne	23	129	129	...	...	271	...	...	...	...	...
Blyth	11	115	118	...	...	283	...	...	...	...	...
J											
Forgandenny	*50*	129	135	...	...	...	89	...	...	...	...
Kirriemuir	...	128	123	...	...	...	...	...	...	...	...
Durris	7	120	125	...	161	...	63	77	115	164	185
Crathes	7	128	127	...	161	...	...	...	115	161	185
Aberdeen	12	132	145	...	...	...	97	158	162	...	...
K											
Invermoidart	27	...	126	...	...	...	...	102	...	...	...
Beauly	*64*	130	131	...	171	...	79	158	167	...	...
Dingwall	15	115	145	...	160	...	63	129	...	...	...
Inverbroom	...	...	126	...	...	...	21	123	146	...	...
Watten	...	...	...	...	...	...	89	...	134	...	191
Mean Dates for the British Isles in 1906	8 Jan. 8	108 Apl. 18	116 Apl. 26	114 Apl. 24	136 May 16	286 Oct. 13	55 Feb. 24	101 Apl. 11	105 Apl. 15	128 May 8	168 June 17
Mean Dates for 1891-1906	Jan. 23	Apl. 17	Apl. 22	Apl. 21	May 15	Oct. 12	Feb. 25	Apl. 12	Apl. 18	May 9	June 11

The dates in *italics* have not been taken into consideration when calculating the means for the British Isles.

July.—*Altarnon* (A)—Wasps scarce. 1st. Snipe first seen. *Coneyhurst* (C)—4th. Cuckoo last heard. *Churt Vicarage* (C)—18th. Meadow brown butterflies unusually abundant. *Harefield* (D)—28th. Wheat and oats first cut. *St. Albans* (*New Farm*) (D)—Turnip and mangold seeds sown this month took 6 weeks to germinate. *St. Albans* (*Glenferrie Road*) (D)—21st. Oats first cut. *Beeston* (D)—28th. Pastures very burnt up. *Hodsock* (D)—21st. Grass very brown. 31st. Harvest began here. *Brunstead* (E)—23rd. Nightjar first heard. *Clenchwarton* (E)—31st. Harvest began. *Birkdale* (*Southport*) (F)—8th. Cuckoo last heard. *Moniaive* (H)—23rd. Corn harvest began. *Durris* (J)—6th. Cuckoo last heard. *Thirsk* (I)—29th. Grass all burnt up.

August.—*Mawnan* (A)—6th. Harvest began. *St. Arvans* (A)—7th. First corn cut. At end of month an unusual number of wasps. *Ovoca* (B)—Wasps numerous. *Geashill* (B)—Wasps numerous and many white butterflies. *Chiddingfold* (C)—31st. A chestnut-tree in my garden is flagging for want of moisture,

TABLE VI.—ESTIMATED YIELD OF FARM CROPS IN 1906.

Description of Crop.	England.						Scotland.			Ireland.	British Isles.
	A S.W.	C S.	D Mid.	E E.	F N.W.	I N.E.	H W.	J E.	K N.	B and G S. and N.	
	%	%	%	%	%	%	%	%	%	%	%
Wheat . . .	+ 7	+ 3	+ 9	+ 6	+ 6	+ 9	+ 3	+ 5	+18	+ 4	+ 7
Barley . . .	+ 6	+ 8	+ 9	+ 8	o	− 2	− 1	− 2	+ 3	− 1	+ 4
Oats	+ 9	+ 7	+12	+ 6	+ 8	− 1	− 3	− 4	+ 4	+ 6	+ 4
Corn Harvest began, average Date, day of Year . .	221	219	221	217	227	227	238	...	...	242	227
Beans . . .	+16	+16	+18	+17	+13	+12	+ 8	+ 5	+ 4	+22	+18
Peas	+17	+ 8	+10	+12	+ 9	+ 6	+ 6	+ 6	+ 9	+11	+12
Potatoes . . .	− 5	+13	+ 1	+12	+12	− 5	− 5	− 4	+14	+ 6	+ 6
Turnips . . .	+10	+ 8	+ 5	− 1	+ 4	+12	+ 9	+ 6	+17	+13	+10
Mangolds . . .	+13	+ 3	+ 2	+ 6	+ 7	+12	+15	+ 4	+36	+16	+ 7
Hay (Permanent Pastures) . .	+ 4	−42	− 2	−36	+ 9	+ 5	+ 2	+ 9	+16	− 9	− 7
Hay (Clover, etc.) .	+ 4	−19	+ 3	−17	+11	+11	+ 5	+12	+ 8	−11	− 1

Symbols:—+ = Over. − = Under. o = Average.

The variations from the average in the above-mentioned crops have been obtained from the *Agricultural Returns*, 1906 (*Produce of Crops*), issued by the Board of Agriculture, while the average dates of the Harvest have been derived from returns which appeared in the *Agricultural Gazette*, July 16 to August 20, 1906.

TABLE VII.—ESTIMATED YIELD OF FRUIT CROPS IN 1906.

Description of Crop.	England.						Scotland.	Ireland.	British Isles.
	A S.W.	C S.	D Mid.	E E.	F N.W.	I N.E.	H, J, and K W. E. and N.	B and G S. and N.	
Apples	−	o	o	o	−	−	−	o	−
Pears	−	−	−	−	−	−	−	−	−
Plums	−	−	−	−	−	−	−	−	−
Raspberries	+	+	−	+	+	−	−	+	+
Currants	+	+	−	+	+	−	−	+	+
Gooseberries	+	+	−	+	+	−	−	+	+
Strawberries	o	+	o	o	+	o	+	o	+

Symbols:—+ = Over. − = Under. o = Average. This Table has been compiled from returns which appeared in the *Gardeners' Chronicle*, July 28, 1906.

TABLE VIII.—VARIATIONS FROM THE AVERAGE IN MEAN TEMPERATURE, RAINFALL, AND SUNSHINE, 1905-6.

WINTER 1905-6.

Temperature.

MONTHS.	Eng. S.W.	Ire. S.	Eng. S.	Eng. Mid.	Eng. E.	Eng. N.W.	Ire. N.	Scot. W.	Eng. N.E.	Scot. E.	Scot. N.
	°	°	°	°	°	°	°	°	°	°	°
December . .	+ 1·0	+ 3·5	+ 1·2	+ 2·0	+ 1·2	+ 2·2	+ 3·7	+ 3·5	+ 2·7	+ 4·2	+ 4·0
January . .	+ 2·6	+ 2·0	+ 3·2	+ 2·9	+ 2·9	+ 2·5	+ 1·8	+ 2·2	+ 2·8	+ 1·9	+ 1·2
February . .	− 1·8	− 2·3	− 1·2	− 1·9	− 1·4	− 2·3	− 2·5	− 2·4	− 2·0	− 2·8	− 3·2
Winter . .	+ 0·6	+ 1·1	+ 1·1	+ 1·0	+ 0·9	+ 0·8	+ 1·0	+ 1·1	+ 1·2	+ 1·1	+ 0·7
Rain.											
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
December . .	− 2·4	− 1·8	− 1·8	− 1·5	− 1·2	− 2·2	− 0·6	− 1·8	− 1·6	− 1·1	− 0·8
January . .	+ 3·3	+ 0·9	+ 2·3	+ 1·5	+ 1·6	+ 2·2	+ 1·8	+ 1·6	+ 0·5	+ 0·4	+ 2·4
February . .	+ 1·3	− 0·1	+ 0·5	+ 0·1	+ 0·5	+ 0·9	+ 0·5	0·0	− 0·1	− 0·5	− 1·0
Winter . .	+ 2·2	− 1·0	+ 1·0	+ 0·1	+ 0·9	+ 0·9	+ 1·7	− 0·2	− 1·2	− 1·2	+ 0·6
Sunshine.											
	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.
December . .	− 4	− 13	− 8	− 5	− 5	+ 16	+ 4	+ 2	+ 5	+ 4	0
January . .	+ 9	− 11	+ 22	+ 11	+ 15	− 6	− 1	+ 4	+ 1	− 1	− 3
February . .	+ 19	+ 18	+ 17	+ 15	+ 9	+ 24	+ 30	+ 34	+ 18	+ 37	+ 11
Winter . .	+ 24	− 6	+ 31	+ 21	+ 19	+ 34	+ 33	+ 40	+ 24	+ 40	+ 8

SPRING 1906.

Temperature.

MONTHS.	Eng. S.W.	Ire. S.	Eng. S.	Eng. Mid.	Eng. E.	Eng. N.W.	Ire. N.	Scot. W.	Eng. N.E.	Scot. E.	Scot. N.
	°	°	°	°	°	°	°	°	°	°	°
March . .	− 1·3	− 0·1	− 1·4	− 0·6	− 0·9	− 1·1	− 0·5	− 0·5	− 0·2	− 1·1	− 1·6
April . .	− 1·0	− 1·6	− 1·2	− 0·9	− 1·4	− 1·0	− 1·1	− 0·3	− 0·8	− 0·3	− 1·3
May . .	− 1·7	− 1·7	− 0·8	− 0·9	− 0·4	− 1·5	− 2·2	− 1·9	− 0·5	− 2·3	− 2·8
Spring . .	− 1·3	− 1·1	− 1·1	− 0·8	− 0·9	− 1·2	− 1·3	− 0·9	− 0·5	− 1·2	− 1·9
Rain.											
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
March . .	− 0·2	− 0·6	− 0·2	− 0·4	− 0·2	+ 0·5	+ 0·2	− 0·2	− 0·3	+ 0·2	+ 0·5
April . .	− 1·2	− 1·1	− 0·9	− 1·0	− 0·9	− 0·7	+ 0·1	− 0·7	− 0·9	− 0·4	+ 0·4
May . .	+ 1·8	+ 0·9	+ 0·4	+ 0·1	0·0	+ 1·6	+ 1·3	+ 2·3	+ 1·2	+ 3·0	+ 1·2
Spring . .	+ 0·4	− 0·8	− 0·7	− 1·3	− 1·1	+ 1·4	+ 1·6	+ 1·4	0·0	+ 2·8	+ 2·1
Sunshine.											
	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.
March . .	+ 18	− 14	0	+ 4	+ 2	+ 27	− 14	+ 20	+ 18	+ 6	− 3
April . .	+ 79	+ 44	+ 66	+ 59	+ 78	+ 62	+ 46	+ 34	+ 61	+ 57	+ 25
May . .	− 51	− 61	− 35	− 60	− 48	− 95	− 76	− 80	− 66	− 49	− 62
Spring . .	+ 46	− 31	+ 31	+ 3	+ 32	− 6	− 44	− 26	+ 13	+ 14	− 40

+ indicates above the average, − below it.

TABLE VIII.—VARIATIONS FROM THE AVERAGE—*continued.*

SUMMER 1906.

Temperature.

MONTHS.	Eng. S.W.	Ire. S.	Eng. S.	Eng. Mid.	Eng. E.	Eng. N.W.	Ire. N.	Scot. W.	Eng. N.E.	Scot. E.	Scot. N.
	°	°	°	°	°	°	°	°	°	°	°
June . .	+0·1	+1·4	-0·9	0·0	-1·2	+0·8	+0·4	+1·0	+0·4	+1·4	+0·9
July . .	-1·0	-0·1	-0·6	-0·1	-0·1	-0·9	-1·1	-1·7	+0·3	-1·2	-1·7
August . .	+2·3	+2·0	+2·7	+3·8	+3·3	+2·7	+2·4	+2·3	+3·3	+1·6	+1·4
Summer . .	+0·5	+1·1	+0·4	+1·2	+0·7	+0·9	+0·6	+0·5	+1·3	+0·6	+0·2
Rain.											
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
June . .	-0·1	-0·5	-0·1	-0·1	+0·4	-0·8	-0·9	-1·5	-0·5	-1·2	-1·3
July . .	-1·6	-0·6	-1·5	-1·5	-1·8	-1·4	-0·8	-0·4	-1·6	-1·3	+1·3
August . .	-0·9	-1·0	-1·8	-1·5	-1·3	+0·2	-0·2	+0·2	-0·1	+1·4	-0·6
Summer . .	-2·6	-2·1	-3·4	-3·1	-2·7	-2·0	-1·9	-1·7	-2·2	-1·1	-0·6
Sunshine.											
	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.
June . .	+13	+11	+ 52	+ 35	+ 42	+27	+11	+17	+15	+ 8	+ 2
July . .	+10	- 7	+ 45	+ 40	+ 48	+26	+14	+32	+43	+29	+22
August . .	+22	+28	+ 53	+ 62	+ 60	+44	+30	- 4	+23	- 8	+ 6
Summer . .	+45	+32	+150	+137	+150	+97	+55	+45	+81	+29	+30

AUTUMN 1906.

Temperature.

	°	°	°	°	°	°	°	°	°	°	°
September .	+0·6	+1·2	+1·1	+1·6	+1·9	+0·6	+1·3	+1·4	+1·9	+1·5	+1·6
October . .	+1·7	+0·5	+3·7	+2·7	+4·3	+1·8	+0·6	+1·8	+2·9	+1·7	+1·4
November .	+1·3	+2·2	+2·7	+2·3	+3·0	+1·8	+2·1	+2·3	+2·9	+2·9	+2·4
Autumn . .	+1·2	+1·3	+2·5	+2·2	+3·1	+1·4	+1·3	+1·8	+2·6	+2·0	+1·8
Rain.											
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
September .	-2·1	-2·1	-1·0	-1·3	-0·6	-1·8	-1·7	-2·1	-1·4	-1·6	-1·3
October . .	+1·5	+1·6	+1·4	+1·6	+0·8	+1·8	+1·1	+0·5	+2·5	+3·6	-0·4
November .	+0·3	-1·9	+1·4	+0·5	+1·1	-0·3	-0·6	-0·4	-0·5	+0·3	+1·3
Autumn . .	-0·3	-2·4	+1·8	+0·8	+1·3	-0·3	-1·2	-2·0	+0·6	+2·3	-0·4
Sunshine.											
	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.	hrs.
September .	+57	+38	+34	+44	+46	+58	+41	+51	+35	+61	+48
October . .	- 2	+ 7	+ 9	-16	+ 5	-15	+11	- 9	-19	-10	0
November .	- 2	-19	- 6	- 3	- 5	0	-12	-12	- 2	- 3	- 7
Autumn . .	+53	+26	+37	+25	+46	+43	+40	+30	+14	+48	+41

The above Table has been compiled from the variations from the mean given in the *Weekly Weather Reports* issued by the Meteorological Office.

TABLE IX.—Supplementary Observations in 1906.

PLANTS.

Winter Aconite.

Station.	District.	Date.
Mawnan . .	A	Jan. 10.
Churt Vicarage .	C	,, 10.
Bagshot . .	C	,, 30.
Watford . .	D	,, 4.
Berkhamsted .	D	,, 7.
Hodsock . .	D	,, 10.
Clenchwarton .	E	Dec. 20.
Cronkbourne .	F	Jan. 8.

BIRDS.

Chiff-Chaff (first heard).

Station.	District.	Date.
Mawnan . .	A	April 6.
Altarnon . .	A	,, 12.
Starcross . .	A	March 21.
St. Arvans . .	A	Feb. 22.
Ovoca . . .	B	March 29.
Cranleigh . .	C	April 20.
Ripley . .	D	,, 4.
Ardgillan . .	G	March 31.
Edgeworthstown .	G	April 5.
Loughbrickland .	G	,, 3.
Altnafoyle . .	G	May 12.

House-Martin (first seen).

Station.	District.	Date.
Skibbereen . .	B	March 25.
Ripley . .	D	April 11.
Odsey (Ashwell) .	E	May 11.
Tacolneston .	E	,, 6.
Westport . .	G	April 20.
Corbridge-on-Tyne	I	May 7.
Durris . . .	J	,, 5.

Corncrake (first heard).

Station.	District.	Date.
Bridgend . .	A	June 3.
Ovoca . . .	B	April 18.
Hodsock . .	D	May 12.
Ripley . .	D	,, 13.
Betley . . .	F	,, 6.
Birkdale (Southp't)	F	,, 18.
Lake Side . .	F	,, 7.
Ardgillan . .	G	April 29.
Edgeworthstown .	G	May 1.
Westport . .	G	April 28.
Chanter Hill .	G	,, 29.
Loughbrickland .	G	May 6.
Altnafoyle . .	G	,, 6.
Moniaive . .	H	,, 1.
Thirsk . .	I	,, 6.
Corbridge-on-Tyne	I	,, 7.
Crathes . .	J	,, 12.

Swift (first seen).

Station.	District.	Date.
Mawnan . .	A	May 7.
Brixham . .	A	,, 5.
Starcross . .	A	,, 2.
Bridgend . .	A	,, 15.
St. Arvans . .	A	,, 6.
Ovoca . . .	B	,, 8.
Cranleigh . .	C	,, 14.
Coneyhurst . .	C	April 18.
Churt Vicarage .	C	May 5.
Oxford . .	D	,, 5.
Harefield . .	D	,, 6.
Hodsock . .	D	,, 4.
Odsey (Ashwell) .	E	,, 5.
Birkdale (Southp't)	F	,, 7.
Altnafoyle . .	G	,, 12.
New Galloway .	H	,, 7.
Corbridge-on-Tyne	I	,, 7.

and apples are falling before they are ripe. *Churt Vicarage* (**C**)—Shrubs flagging owing to drought. *Harefield* (**D**)—7th. Barley first cut. *St. Albans* (*New Farm*) (**D**)—Wasps very numerous. 30th. Harvest finished. *St. Albans* (*Glenferrie Road*) (**D**)—18th. The first mushrooms. *Farnborough* (**D**)—Wasps very numerous. *Beeston* (**D**)—3rd. Harvest began. 31st. Gardens very parched. *Hodsock* (**D**)—15th. Grass wonderfully green. 27th. Harvest finished. 30th. Saw many trees with foliage shrivelled. *Hatfield* (**E**)—31st. The foliage on some of the beeches is brown and shrivelled owing to the drought. Wasps very numerous. *Lexden* (**E**)—Practically all the grass was dried up by the drought. *Southacre* (**E**)—Many trees lost their leaves weeks earlier than usual. *Brunstead* (**E**)—2nd. Oats first cut. 31st. Dragon-flies unusually numerous. *Betley* (**F**)—13th. Barley cut on 6th still in stooks. *Birkdale* (*Southport*) (**F**)—8th. Harvest began. Very few wasps. Coleoptera very scarce. Lepidoptera, especially butterflies, exceptionally numerous all the summer. *Lake Side* (**F**)—

21st. The last field of hay carried. *Cronkbourne* (F)—Wasps very numerous. 11th. Harvest began. *Milford* (G)—Scarcely any wasps. *Jardington* (H)—23rd. Harvest began.

SEPTEMBER.—*Mawnan* (A)—20th. A swarm of bees at a farm near. *Altarnon* (A)—24th. Dahlias partly blackened by frost. *Ovoca* (B)—At end of month rhododendrons and other garden plants drooping and sickly for want of rain. *Botley* (C)—30th. Grass very short through drought. *Churt Vicarage* (C)—2nd. Some forest trees, notably the elm and birch, are turning yellow as in late autumn. *Harefield* (D)—9th. Swift last seen. *St. Albans* (*New Farm*) (D)—Late blackberries very fine and plentiful. *Northampton* (D)—By the middle of the month the leaves of the lime-trees had become quite yellow, and many had fallen. *Beeston* (D)—11th. Ponds and cisterns empty and pastures bare. *Hodsock* (D)—1st and 2nd. Temperature 93° with brilliant sunshine. Flowers seemed scorched. White Japanese anemones turned brown—not flagging, but burnt. 11th. Many beeches almost bare of leaves. Grass quite brown. 19th. Since rain on 13th beech leaves have entirely ceased falling. *Macclesfield* (D)—The very hot period August 29 to September 3, with a record shade temperature of 90° and dry atmosphere (relative humidity 53), caused many leaves to shrivel and fall off, especially those on the sycamores. *Bocking* (E)—Blackberries and acorns abundant. The common "oak-apple" was very plentiful, making some of the oaks look like apple-trees with a respectable crop on them. *Lexden* (E)—Limes lost their leaves very early, while the foliage on the maples was scorched by the heat and drought. Grass completely burnt up. *Clenchwarton* (E)—7th. Harvest ended. *Betley* (F)—Wasps very numerous. *Thirsk* (I)—15th. Wasps very plentiful.

OCTOBER.—*Mawnan* (A)—18th. Extraordinary amount of holly berries and hawthorn berries. *Altarnon* (A)—30th. Has been a good season for bees and honey. *Bembridge* (C)—20th. Butterflies, bees, and wasps plentiful on many flowers. *Botley* (C)—11th. Larch full of fresh green shoots, like spring. *Churt Vicarage* (C)—7th. French beans destroyed by frost in lower part of parish. *Harpenden* (D)—11th. 33 different species of wild flowers were noted in bloom here. *Farnborough* (D)—Gnats very numerous throughout the autumn. *Beeston* (D)—Grass wonderfully green, considering how brown it has been. *Hodsock* (D)—11th. Leaves have not fallen much since early in September. *Birkdale* (*Southport*) (F)—5th. A laburnum-tree in garden quite green with new foliage of small leaves. 25th. Fieldfares numerous.

NOVEMBER.—*Altarnon* (A)—30th. Large crops of late mushrooms. House-flies very numerous during the last fortnight. *Penarth* (A)—15th. Scarcely any leaves have as yet fallen. *Havant* (C)—Swallows, house-martins, and sand-martins have remained unusually late, all three having been seen as late as the middle of the month. *Botley* (C)—12th. Leaves still on beeches, elms, etc., colour splendid. 19th. Dahlias killed by frost. 27th. Oaks still with many leaves. *Cranleigh* (C)—26th. Pipestrelle bat seen. *Churt Vicarage* (C)—6th. Dahlias killed by frost. 23rd. The change and fall of the leaves, though late, has been very rapid when it once began. *Chesham* (D)—29th. Small bat seen. Alpine strawberry in flower. *St. Albans* (*New Farm*) (D)—Leaves remaining on trees longer than usual. *Berkhamsted* (D)—13th. Dahlias killed by frost, 8 days later than the average date of their destruction in the previous 21 years. *Farnborough* (D)—Dahlias killed during the last week of the month. *Northampton* (D)—I have rarely seen the elms, oaks, and hawthorns retain their foliage so late. *Hodsock* (D)—Trees nearly all bare by end of month. 4th. Grass very green. *Odsey* (*Ashwell*) (E)—4th. Wych-elm and birch have lost most of their leaves. 19th. Common elms still retain most of their leaves, which are now yellow. 25th. Common elms alone retain their leaves, nearly one half. 29th. Elms and all other trees practically bare. *Tacolneston* (E)—

6th. Fieldfares first seen. 18th. Dahlias killed by frost. *Southacre* (E)—28th. Grass growing fast in fields. *Clenchwarton* (E)—26th. The autumn tints are now very fine. *Llangollen* (F)—14th. Dahlias killed. The woods were in leaf and beautifully coloured until the 15th. *Betley* (F)—30th. Roses still in flower. *Birkdale (Southport)* (F)—Holly berries fairly plentiful. *Lake Side* (F)—29th. Gathered a few rose blooms. Found primroses in flower in a wood. *Cronkbourne* (F)—30th. Laurestinus in full bloom. *Jardington* (H)—Grass quite green at end of month.

DISCUSSION.

Mr. H. Mellish said that they owed a great deal to Mr. Mawley for the trouble he took in bringing these observations before the Society. Mr. Mawley had referred to the late hanging on of the foliage, and also to the way in which it turned colour early in the year. This was very well marked in Nottinghamshire. During the heat early in September the leaves came off in clouds ; some of the elms and beeches became almost bare. In the third week of that month this stopped with the advent of rain, and ultimately they hung on very late, and those which had not already changed colour kept it well into November. The heat also brought a plague of wasps, which had attacked the fruit, so that it had to be picked unripe to save it. Mr. Mawley had referred to the time of the finish of the harvest. There seemed to be less difference than usual in the date of this in different districts. There was corn out nearly as far south as London a fortnight after it had all been cleared in the North Midlands.

Mr. J. E. Clark said he thought the Report this year was of unusual interest. One point to which they had their attention called was further investigation. They had all thought, early in the year, that a good harvest was impossible, yet it had taken place. How were they to account for the remarkable results when the crops were reaped? He thought that if Mr. Mawley could give the percentage of excess in the various crops, it would be more informing. The continuous sunshine, which occurred after the dull weather in May, probably had a good deal to do with the final results. Yet it was interesting to notice that the results were not equal to the average in some crops, namely, out-door tomatoes, American squashes, and sweet corn. If such crops are unable to get a good start, the excess of late-season sunshine would not make up for this loss, although they were probably favoured with the heat at the same time in America. He had also noticed the peculiar recovery in the tree foliage. It was very marked round Croydon. One other point worth noticing was the very great increase in the mischief done by birds. He did not know whether any full explanation had been given ; possibly the birds had been spared so much during recent winters by the mildness of the winter that the numbers had been much greater. This certainly applied to the starlings.

Mr. F. C. Bayard remarked that they were much indebted to Mr. Mawley for his Reports, in continuation of the old Reports which Mr. Preston gave them. Mr. Mawley's Reports became more valuable as time went on. He thought that Mr. Mawley's plan of contrasting a less number of plants as against the larger number of Mr. Preston's gave better results than Mr. Preston had given, and consequently the work of the phenological section was much more accurate. Regarding the wasps, he had not noticed so many at Wallington as usual, except in the middle of September. He thought the very wet June had killed off a good many. It was, however, curious that the wasps stayed till the middle of December. October was exceedingly warm, and also November. Mr. Bayard expressed the wish that Mr. Mawley would take at least one insect as well as plants for his maps, which would enhance the value of his Report. The fact that they had many or few insects gave a much more vivid idea of the character of the season than even a great mass of flowers or fruit.

Mr. J. Hopkinson said that weather which favoured some kinds of fruit did not always favour others. Thus in 1905 he had (at Watford) very few apples and not many currants, but a plentiful supply of gooseberries; while in 1906 apples were abundant, and currants did well, but very few gooseberries ripened. In 1905 he had a good crop of hay, but in 1906 it was almost a complete failure, not being worth the expense of making. Although he approved of the Wild Birds Protection Act, he thought it was in some measure responsible for the increased number, and therefore depredations, of our birds.

Mr. W. W. Bryant said there was often a bounty on the nests of wasps, especially in the year following a plague of wasps, and it would be difficult to make due allowance for nests destroyed. Curiously enough, the only month in 1906 in which the sunshine at Greenwich was an absolute record was October, a month stated by Mr. Mawley to have been generally deficient.

Mr. E. Mawley in reply said that from the remarks made by Mr. Mellish it was evident that the long summer drought had been keenly felt by vegetation even as far north as Hodsock. He did not think an investigation as to the distribution of wasps would be of any special value, as in most years their numbers varied greatly in different localities from year to year, and no doubt, as Mr. Bryant had pointed out, these variations must often be dependent upon whether their nests had in any district been rigidly searched for and destroyed or not. The remarkable burst of heat at the end of August and beginning of September, which appears to have been general throughout the country, was no doubt answerable for the harvest having taken place last year much more nearly at the same time all over the British Isles than usual. Mr. Mawley could not understand why with such apparently adverse seasons the yield of all the farm crops, except pasture hay, should have come out in the *Preliminary Statement of the Board of Agriculture for Great Britain*, above average. Perhaps when the complete returns were published it would be found that if the results for the northern counties of England and for Scotland, where the weather appeared to have been more favourable, were excluded, that the estimated results for the rest of the country would then be seen to have been less satisfactory for some of those crops. He thought that the unusual dryness of the air during nearly the whole of the summer, and more particularly at the end of August and beginning of September, was responsible for the poor growth made by many trees, shrubs, and other plants during 1906. The increased number of small birds in recent years was no doubt, as Mr. Clark had said, due in a great measure to the general mildness of recent winters. As netting the small fruits had now become very general, those gardens where no such protection was afforded them must of course suffer more now from their depredations than formerly.

The President, Dr. H. R. Mill, thought they owed their hearty thanks to Mr. Mawley for his Report. This entailed an enormous amount of work, and he could not but admire the wonderful brevity and clearness with which the mass of detail was generalised and set forth. He had always valued the Phenological Reports as scientific documents, but last year he had gone to live in a house with a large garden and this had revealed to him the intense human interest of the subject. That was perhaps the reason why he had enjoyed hearing the Report this year more than ever before; it explained so many points regarding garden crops which had puzzled him, and showed that certain backward fruit trees were only supporting the general character of the particular season. Mr. Mawley in his handling of these Reports became every year more of a pattern to meteorologists as well as phenologists.

The Alps as a Weather-parting.

The meteorological studies at stations on Alpine heights—especially those relating to the nature of *Föhn*—have led to a more precise determination of the part played by the Alps as a dividing-line in regard to the temperature of the European continent. In his "Transport kalter Luftmassen über die Zentralalpen" in the eightieth volume of the *Denkschriften der math. naturw. Klasse der kaiserl. Akademie d. Wissenschaften in Wien*, 1906, Heinz von Ficker, assistant at the Central Institute for Meteorology and Geodynamics in Vienna, sums up the question in the following words:—"The Alps are not merely a geological—they are no less also an extraordinarily important meteorological—line of disturbance. In no case is this more clearly seen than in following a cold mass of air which has struck against the northern Alps in its passage across the Alps. It is then evident how the Alps do not indeed ward off the Northern winds, but by compression warm the cold air-masses; and so, in most cases, protect the southern stations from the sudden and intense variations of temperature prevailing on the north side.—*Geographical Journal*, January 1907.

Meteorology in the Antarctic.

It will be remembered that several members of the staff of the recently closed Ben Nevis Observatory left more than a year ago to continue the meteorological and magnetic work initiated in March 1903 by Mr. W. S. Bruce, leader of the Scottish National Antarctic Expedition, at Scotia Bay, South Orkneys. News has been received from Buenos Ayres to the effect that the Antarctic research ship *Uruguay* left that port on December 11 last for the South Orkneys with a party under the leadership of Mr. Angus Rankin, late superintendent of the Ben Nevis Observatory. Included in the party is Mr. Meldrum, a son of the late Dr. Meldrum, C.M.G., of Mauritius, who is well known for his meteorological work.

The *Uruguay* takes plenty of provisions in case the party has to winter in these latitudes, as it is understood that the ice conditions this year in the south are exceptionally bad, the pack lying farther north than previously recorded.

On the return of the *Uruguay* to Ushiaia, the second party, consisting largely of members of the late Ben Nevis Observatory staff, under the leadership of Mr. Bee, was to leave for Wandel Island, at the southern extremity of Gerlache Strait, Charcot's winter quarters, where a new meteorological and magnetic station will be established.

Before leaving Buenos Ayres, Messrs. Rankin and Bee were invested by the Argentine Ministry with the official insignia of office pertaining to the position of Political Officer for these places, so that by this time their formal annexation to the Argentine Republic has been consummated.

The station at South Georgia is also being continued, while the installation of parties on one of the islands of the South Sandwich Group, as well as on the west side of the Falklands, is contemplated in the immediate future.

This comprehensive scheme of work cannot fail to very materially advance our knowledge of the meteorology and magnetism of the area lying to the south and west of Cape Horn, especially as the meteorological service of the Argentine Republic is already in a high state of efficiency. This elaborate programme is largely due to the initiative and enterprise of Mr. Walter G. Davis, Director of the Argentine Meteorological Office, whose efforts have been cordially supported by the Ministry of that country.—*Scottish Geographical Magazine*, February 1907.

THE METRIC SYSTEM IN METEOROLOGY.

By RICHARD INWARDS, F.R.A.S., F.R.Met.Soc.

[Read February 20, 1907.]

It is not my intention in this paper to discuss the question of the advantages of the metric system of general weights, measures and values over that in use by Britain and her colonies and the United States of America; but I shall confine my brief remarks to the manifest advisability of adopting for scientific purposes a uniform system by all the meteorological observers upon the globe.

For mere local comparisons and forecasts over a limited area it is obviously of not much importance what units of measurement are adopted; but it is not so for wider investigations in what may be called whole-world meteorology, where the observations are taken in many widely separated countries and where it is of the greatest importance that they should be capable of being compared easily with each other, and for this purpose should be made on one common system of measurement.

If one contemplates, for instance, any task in which the factors consist of records of rainfall, temperature, or pressure over the whole world, the labour of reducing the observations to a common measure is absolutely enormous, and one stands in astonishment at the work of such men as Sir A. Binnie, Dr. Buchan, and others who have dared to attack such difficulties.

Even where the system generally in vogue is open to minor objections, the advantage of uniformity is so great as to outweigh any want of perfection in non-essentials.

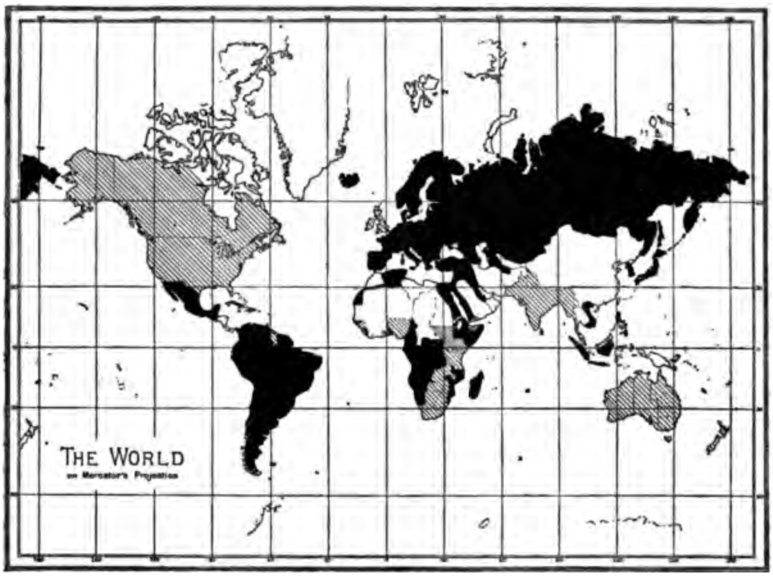
The time, it seems to me, is now come to take into careful consideration the matter of conforming the British and American units of observation with those of the rest of the world.

It may be taken as axiomatic that twenty nations which have, after grave consideration, adopted the system known as metric, will never go back to any more local or less philosophical methods; and I do not know of any instance where it has even been proposed to do so.

It therefore reduces the question to whether the two outstanding powers, viz. Great Britain and the United States, should not bring themselves into line with the rest of the world and make their observations on the plan adopted by the majority.

In the case of our intelligent allies, the Japanese, who were of course free to select any system they chose, they at once declared in meteorology for the metric method; and I am glad to see that we have in our library several volumes of minute and valuable observations taken on this system by them, without intermission, during their recent arduous campaign in Manchuria. I believe it is also true that the United States have continued the metric observations in the Philippines without change, and it is certain that Mr. Rotch of the Blue Hill Observatory in Massachusetts has adopted the metric system for years, and now gives his observations in both styles. His conversion tables would be most useful when we ourselves make the change of system.

China is at present almost out of the race in meteorology, but it seems morally certain that when the matter is seriously taken up by that country it will follow in the track of Japan and adopt the metric method. Indeed, I do not see how even a British or American adviser could counsel them to do otherwise.



METRIC ■ NON-METRIC ▨

Here is a map of the world showing the countries which have already adopted uniformity in metric meteorology. These are marked black upon the map, while the non-uniform countries are shaded with diagonal lines, and the parts where observations are non-existent are left white. From this map it will be seen that the following countries are arrayed on the side of metric uniformity against Britain and the United States with their colonies on the other side:—

Countries adopting the Metric System in Meteorology.

Argentina
Austria
Belgium
Bolivia
Brazil
Chile
Denmark
Egypt
Finland
France
Germany
Greece
Holland
Hungary
Italy
Japan
Mexico
Norway
Ottoman Empire
Paraguay
Peru
Portugal
Rumania
Russia
Servia
Spain
Sweden
Switzerland
Uruguay

The whole of the countries in South America, minus British Guiana, may be said to be adherents to the metric system, although some of the republics do not publish meteorological information.

In the matter of population I find that the countries above named as making use of metric units, have an aggregate population of about 370 millions against about 330 millions which form the population of the non-metric countries, viz. Britain and her colonies plus the United

States of America. More than 200 millions of this latter total are inhabitants of India.

In looking at my map it will be seen that such countries as China, Arabia, Persia, Afghanistan, Tibet, and the polar regions do not come into this calculation at present. It must also be borne in mind that the map being on the projection known as Mercator's, undue prominence is given to the northern parts of Asia and America, the one marked black and the other shaded. Large desert areas such as the interior of Australia are shaded non-metric on the ground that the scanty observations available are on that system.

But in considering the balance of scientific opinion on this subject, neither area nor population have such weight as the total number of the scientific publications issued in the countries under review. I quote from Professor A. Schuster's Royal Institution lecture the following table, which gives the number of the index slips of reference to scientific papers sent in for the Royal Society's *International Catalogue of Scientific Literature*, up to the summer of 1905, the publications for the most part being those issued since 1901:—

Metric.		Non-Metric.	
Austria	13,186	Canada	537
Belgium	2,272	India	2,699
Denmark	2,584	N. S. Wales	2,049
Finland	1,828	N. Zealand	440
France	60,401	S. Africa	1,872
Germany	213,545	S. Australia	159
Holland	9,861	United Kingdom	56,382
Hungary	2,605	United States	66,071
Italy	21,238	Victoria (Australia)	2,858
Japan	3,043		
Norway	2,017		
Poland	5,820		
Russia	25,741		
Sweden	1,639		
Switzerland	5,140		
Total	370,920	Total	133,067

Germany (metric) heads this list with a number greater than any other four nations put together.

In point of numbers England (non-metric) comes 4th in the list.

It will be seen from this that the scientific publications under the metric system are more than double in number those of the non-metric.

I have not a list of the various colleges, technical schools, and universities in Great Britain which already adopt the metric methods, but the number is considerable, so that a vast body of students in this country are already accustomed to think and write in millimetres and kilograms.

As to languages, there may be said to be one—the English—employed on the non-metric work, while at least nine are arrayed on the side of the metric system.

The Meteorological Congress held at Vienna in 1874 passed the following resolutions:—

1. For observations as well as for publications the use of the same units of measure is desirable.
2. The Congress expresses its conviction, that among all the existing systems of measure, the metric has the best prospect of universal adoption.

3. The Congress declares it to be most desirable (if it be not possible to introduce uniform measures at present) to use henceforth only metric and English measures (with Celsius and Fahrenheit scales).
4. All action to be supported which tends to the introduction of the uniform metric system. The results of observations, or the means, should be published in the metric (and centigrade) scales in addition to appearing in the original scales.

On the other side it is fair to give proper weight to the various objections to be urged against the change.

The first and greatest objection is the labour, inconvenience, and cost involved in the alteration of instruments and in the preparation and printing of new meteorological tables. This is not to be denied, but it is only the same problem which has been faced by many other nations, less wealthy than those now concerned, when they have seen fit to make a similar change.

Then there is the consideration of the great preponderance of English and American shipping making the subject of the collection of observations on the oceans of the world much easier for those nations than for others. To this it may be said that other nations are fast increasing their navies and passenger steamers, and that masters of ships form a class already accustomed to mathematical calculations, and could make the change of units with perhaps less inconvenience than could any other class of observers.

The usefulness of the observations already recorded by the British and American meteorologists can in a broad sense be no way lessened by the adoption of a uniform system in the near future, for even if we have to convert our old results and totals into metric measures, yet all the outside world will be saved for ever from the labour of reducing our own and the American observations to a common standard before being able to make any progress in whole-world meteorological science. We also shall have the inestimable benefit of at once being able to compare our figures with those of all other nations. With confident expectation we may, I think, look forward to the time when the whole world will have but one system of meteorological calculation, and as the matter of the reconstruction or alteration of some of the standards, units or zeros, is now "in the air," it would give a good opportunity, if changes must be made, to adopt in England and America the same system which has been for so long a time in use on the Continent of Europe and over a great portion of the land surface of our planet.

DISCUSSION.

Mr. W. H. Dines remarked that he had nothing in particular to say about the paper, except that it was certainly a nuisance to have two scales.

Mr. W. W. Bryant said that regarding the *International Catalogue* the Americans had already complained. He thought the Germans had not exercised as much judgment as they should in leaving out things of no particular value.

Mr. R. H. Curtis remarked that although he agreed it was inconvenient to have two scales in use, yet he thought the difficulties in the way of making a change would prove so great that it would not be practicable to effect it for a long time to come. In the case of pressure the difficulty would not perhaps be very great, because to the minds of most people "29·8" or "30·0" does not convey a much more definite idea of what is really meant than would "757" and "762." As regards temperature, however, the case is rather different, for the meaning of "32°" and "62°" etc., is more or less generally understood; and everybody knows at once what is meant when the fall of rain is expressed as being so many inches, and it would not be easy to get them to realise so clearly a fall expressed in millimetres.

Mr. H. MELLISH said that the metric measures would come in in Meteorology for barometric readings and rainfall. He thought to change the barometric scale would be practicable, but not the rainfall. Most of the people who took barometric readings possessed a scientific training, but this was not so regarding rainfall. They depended for rainfall observations on all sorts of people, and would find it very difficult to get all of them to measure by the metric system. It would be a difficult question to apply the metric system to rainfall, though he considered it quite possible for barometric readings.

Mr. F. C. BAYARD remarked that Mr. Inwards laid great stress upon the map in his paper. He did not wish to criticise this map, but Mr. Inwards had taken the Turkish Empire as one country using the metric system, and the Russian Empire as another. There were a good many nations in both the Turkish and Russian Empires, and he did not think that all of them had heard anything at all about either the metric or non-metric measures. Of course, they knew that in these different places there were stations established by the Central Government, and the observations are made according as it directs, in the metric or non-metric measures. The official observer was sent out, who took the observations as his Government required. If the map were analysed it would be at once seen that it fell to pieces. Mr. Inwards had said that the natives of India were not to be reckoned with as of any account, but they must then at the same time apply this to the natives of Siberia, Arabia, and different parts of Asia Minor, who knew nothing about the system. The map practically came to this, that there were more stations using the non-metric measures, and more people than used the metric. The principal part using the metric were parts of the old Spanish Empire, South America for instance, and a good deal of Argentina; parts of Germany and Russia; but when you went beyond the Urals, the vast Siberian nations used neither measure. Mr. Inwards said that it would be a great advantage to use the metric system for the sake of uniformity, but the question was whether the uniform system should not be non-metric instead.

Mr. W. MARRIOTT remarked that he had hoped not to have taken part in the discussion, as he did not wish to say anything likely to unsettle the observers in this country. With regard to the proposed adoption of the metric system, he thought that the whole question might be very much more simplified than it was if those who wrote papers would write them more simply. The publications of the Royal Meteorological Society were mainly intended for the Fellows, who were nearly all British subjects, and it was only right, therefore, that they should be in the recognised scales of this country. When any translation or foreign paper came in with the metric values, he always endeavoured to put the equivalent British values against them, so that they could readily be understood by any one. If other Institutions and Societies would do the same, we should then get more accustomed to the various scales. If the metric system were adopted, what would become of the terms "mile," "foot," "inch," etc. We calculate the velocity of the wind in "miles per hour," and not in "metres per second." We think of trains travelling at the rate of so many miles per hour, but do not estimate their speed in metres per second. Regarding the Table of the number of papers in the *International Catalogue of*

Scientific Literature, he thought that it would be well if Mr. Inwards would withdraw that Table, as it did not represent the case correctly, and so was misleading. The figures were the total entries in the catalogue, and not of the individual papers by authors. Many of the titles were, in fact, repeated in the "subject" portion under five or more headings; and, as this occurred very largely with foreign publications, the numbers were unduly increased. The Royal Meteorological Society was responsible for the compilation of the titles of meteorological papers published in the British Isles, and he (Mr. Marriott) therefore knew something of the value of that part of the work. They had in the library of the Society a Meteorological Bibliography which they tried to keep up to date, and so they were able to find out what the proportion was that the *International Catalogue* contained compared with what was in their own Bibliography. He would take two instances, one of metric and the other of non-metric. During the period covered by the Table in Mr. Inward's paper, Dr. Hann of Vienna was credited in the authors' section with 207 entries, and Prof. Cleveland Abbe, the editor of the *Monthly Weather Review* in Washington, had 228 entries during the same period. There was not much difference; but in the *International Catalogue* for the same period Prof. Abbe had 80 entries against Dr. Hann's 162. Dr. Hann had therefore double the number credited to him. But what were these papers? A large number of the articles for which Dr. Hann got the credit were merely summaries of papers written by other people. If this plan had been adopted in this country, he (Mr. Marriott) would have to be credited with most of the Notes, etc., which appeared in the *Quarterly Journal*. If the *International Catalogue* had been prepared on the same plan for the other sections of science, the table given by Mr. Inwards was hardly to be relied upon. Mr. Marriott stated that a few years ago Prof. R. de C. Ward had made a translation into English of Dr. Hann's *Climatology*, but gave the foreign measures instead of converting them into the English ones, and so spoilt the value of the book, which was intended for English-speaking people. If they could give both scales side by side, it would be an advantage.

THE PRESIDENT, Dr. H. R. MILL, said that in 1899 he read a paper at the International Geographical Congress at Berlin on the advisability of introducing the metric system and centigrade thermometer scale in all works on scientific geography. The cases were very similar. All that was claimed by those who wished to introduce the Continental system of measures into the sciences of Meteorology and Geography had already been conceded in other branches of science, chemistry for instance. When he was a student twenty-five years ago, all the work in the laboratory was already done in units of the metric scales, and this, instead of hindering the learner, rather helped by enabling him to get fresh and more original views. If the change were made regarding rainfall, it would certainly add to the miseries of his own life, but he would sacrifice a good deal for the sake of uniformity. In Germany the metric system and the centigrade system have been long in use, but the older scales were still used by the people, who spoke familiarly of pounds and feet, although for convenience the pound was taken as half a kilogram. Regarding temperatures, the scale in popular use both in Germany and Russia was the Réaumur, not the centigrade; the latter was universal only for scientific purposes. Mr. Inwards suggested that they should use one scale for international work, but their own scale for ordinary home work, and that appeared a reasonable course. Dr. Shaw had suggested changing the barometer scale so as to read to absolute units of pressure, and thereby involve equality of sacrifice both for English-speaking people and others. Possibly if their friends on the Continent were to have as much trouble and inconvenience in changing the scale as they themselves would have, there would be a better basis for arriving at the best results. The Celsius scale was a very interesting one, and he had had an opportunity of seeing one of the thermometers graduated by Celsius himself, at Upsala. Boiling point was marked zero and freezing point 100°, the temperatures being read downward, not upward, on the stem, so that for all meteorological purposes the minus sign was never required. Any one with experience of reading Arctic measurements would appreciate this. The centigrade thermometer only included one of Celsius's suggestions, that of having 100 degrees between the freezing and boiling points. It presented no other advantages over the Fahrenheit scale. It would only be in the interests of uniformity that it would be at all advisable to sacrifice their present system of recording. The question was whether scientific observers should convert inches into millimetres, and Fahrenheit into centigrade degrees, for the purpose of printing in scientific publications; existing instruments would continue to be read in the old scales until these became unfamiliar. The controversy was no new one, and the leading argument was the same now as fifty years ago when Prof. James Rankine wrote his amusing lines on the subject, with the refrain—

> For I'm a British workman too old to go to school,
> So by pounds I'll eat, and by quarts I'll drink,
> And I'll stick to the three-foot rule.

Mr. R. **Inwards** said in reply that he had scarcely hoped to convert the Society all at once to so important a step as the adoption of the metric system in Meteorology. With regard to the map, he thought it a fair statement of the facts of the case, and if a few thousand Tartars were included as supporters of the metric system, it was also true that 200 millions of the inhabitants of British India had been reckoned on the non-metric side. Mr. Marriott's objection to the figures respecting the number of German and other papers on Meteorology indexed by the Royal Society he did not consider fatal, as if half the German totals were deducted, or even if the whole number were omitted, there would still be a balance in favour of the "metric" contributions to meteorological literature. He thanked the President for his appreciative observations.

A Cape Hailstorm.

The *Queen's Town Free Press*, of Cape Colony, reports a storm in its own district which shows that the exceptional weather of the present year has not been confined to the Northern Hemisphere. In Queen's Town itself the storm was confined to an hour's vivid lightning and torrential rain, during which 1·29 ins. fell, but in the country around there was quite phenomenal hail. A farmer named Palmer, whose fruit and other crops suffered, says the remarkable feature of the storm was the tremendous size of the hailstones. Some of the stones measured 3½ ins. by 2½ ins., and one stone which he picked up an hour after the storm had abated measured 4½ ins. in length and 4 ins. in girth. The approach of the storm was in itself a weird sight—huge black, threatening clouds, rolling mist, and the roaring of the coming hail being fearful harbingers. So dark was it that candles had to be used indoors. The majority of the farmers suffered losses in small stock, no fewer than fifteen sheep being killed on one farm and twenty others injured. In some cases the sheep sustained broken legs through the falling hail. At Essex railway station not a single pane of glass escaped. At Cyphergat a hotel had eighty panes smashed. One sheep was killed by the hailstones, and others had their eyes knocked out. The farms suffered severely.—*Daily Graphic, February* 28, 1907.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

January 16, 1907.

Ordinary Meeting.

RICHARD BENTLEY, F.S.A., President, in the Chair.

Col. ALFRED BIBBY, Bordean House, Petersfield ;
CHARLES SELTH BILHAM, 13 Cambridge Road, Southend-on-Sea ;
BENJAMIN LAURENSON BRADLEY, Grindleford, *via* Sheffield ;
Col. HENRY BURTON, J.P., Newport, Mon. ;
KRISHNA CHOWDRY, 6 Pollock Street, Calcutta ;
ERNEST GEORGE CROCKER, H.M. Naval Establishment, Rosyth, Fife ;
Capt. CHARLES ETTI, 98 Leadenhall Street, E.C. ;
RALPH FALCON, M.A., Cammerton Hall, Workington ;
WILLIAM CARLISLE GEORGE, Cairo, Egypt ;
HENRY THOMAS GIBSON, Te Mata, Raglan, New Zealand ;
EDWIN O. GILBERT, P.W.D., Lahore, Punjab, India ;
HENRY FOULKES KINGDON, Quethiock, Horsell, Woking ;
Gen. HUBERT LE COCQ, Clifton, Guernsey ;
JOSEPH WILLIAM LOVIBOND, J.P., Lake House, near Salisbury ;
CHARLES WILLIAM MALLINS, 5 Strathmore Road, Liverpool ;
LAWRENCE MILES, Rosebank, Strawberry Vale, Twickenham ;
Lord MONTAGU OF BEAULIEU, V.O., D.L., 3 Tilney Street, W. ;
MORGAN MORGAN, 40 High Street, Gorseinon, Glamorgan ;
DAVID LESTER RICHARDSON, 3 Cursitor Street, W.C. ;
ERIC S. A. SMITH, Norwich ; and
MARCUS WILLIAM ZAMBRA, 74 Marlborough Mansions, West Hampstead,
were balloted for and elected Fellows of the Society.

January 16, 1907.

Annual General Meeting.

RICHARD BENTLEY, F.S.A., President, in the Chair

Mr. W. W. BRYANT and Mr. A. HANDS were appointed Scrutineers of the Ballot for Officers and Council.

REPORT OF THE COUNCIL.

THE PRESIDENT, Mr. RICHARD BENTLEY, asked that the Report, being printed and in the hands of every one, might be taken as read. He mentioned that there was actually an increase in the effective Roll of Membership, but owing to several of the names of Fellows who had not been heard of for some time having been removed, the numerical value was unaltered. One of the more important features of the Report was (as stated on page 1) the effort being made in conjunction with the Meteorological Office to avoid a considerable amount of duplicate work ; and although this had not yet been carried through, he hoped that in co-operation with the Meteorological Committee and the Scottish Meteorological Society they might arrive in the near future at some scheme which would obviate a good deal of unnecessary and overlapping work. During the course of the past year a very serviceable Committee had sat, which had done much work in revising the work of the office and bringing the arrangements up to date. Their best thanks were also due to Dr. Williams for his kindly and most useful gift of a typewriter. The President further drew attention to Appendix I. to the Report, which contained the usual documents of a purely business character. These would be found to be in a very satisfactory condition. He then moved "That the Report of the Council be received and adopted, and that it be printed in the *Quarterly Journal.*"

Mr. F. C. BAYARD, in seconding the adoption of the Report, said that it was of a very satisfactory character. The President had omitted to mention one point—representation at the Scientific Meetings abroad. They had been asked by different Societies and also by the Belgian Government to send representatives to certain Meetings. These representatives had been duly sent, and had received the thanks of the different bodies, whose cordiality had been greatly appreciated. The only other thing needing mention, a subject of congratulation and very deep interest, was the additions to the Library. He did not know that there was another Meteorological Library equal to the one in the Society's possession. A great deal was owing to the late Mr. Symons, who had made a large addition to their Library. This gift, added to what they already possessed, had made the Library worthy of the name of the Society, and, he might say, of Great Britain.

The Resolution was adopted. [The Report will be printed in the next issue.]

PRESENTATION TO MR. W. MARRIOTT.

While the ballot was being taken, THE PRESIDENT said :—Mr. Marriott, Sir, I have the pleasant duty, entrusted to me by the Council this evening, of placing in your hands a very slight testimonial of the great esteem and regard which all connected with this Society feel for you. You have for so many years, nearly a third of a century, been identified with the fortunes of the Society, have taken a very large part in the internal work of the office, besides being always at hand to give particulars of past events from the archives, and information upon any point required. Not only this, but when we search the index of the Society we see a long list of contributions to the *Quarterly Journal* from your pen, and when we look on its shelves we see volumes like the *Hints to Meteorological Observers* and *Some Facts about the Weather*, not perhaps bulky ones, but full, in a summarised form, of most valuable information, given in a succinct form for instant reference. You have also travelled about in all parts of the Kingdom, collecting observations, and training the observers in the way of carefully taking the readings and understanding the various instruments, which have extended over many years. This little tribute of our goodwill and appreciation of the many duties to which you have so generously given your time—not only in office hours but out of them—will convey to you the feeling of the Council and of all your colleagues in the Society. During the past year a further task has been laid upon your energies. Scientific Societies in co-operation and affiliation with us have constantly invited lectures and demonstrations not only in London but in the provinces. We have all heard of the successful issue of these, and how largely that success has been owing to the interesting way in which you have been able to convey the information to many thousand auditors. It is in recognition of all these services—which I hope will continue for many years—that I am desired this evening to place on record this little appreciation of the valuable work you have already done for the Society. I hand over to you this Address, illuminated on vellum, which has been signed by the President, Vice-Presidents, Officers, and Council of the Society.

"*ROYAL METEOROLOGICAL SOCIETY.*

"THE first course of Lectures and Exhibitions given on behalf of the Royal Meteorological Society having proved so popular as to lead to a further continuance, the Council of the Society avail themselves of the opportunity of placing on record their appreciation of the able manner in which **Mr. William Marriott** performed the duties of Lecturer and Demonstrator, which contributed greatly to the success of the scheme.

"The Council desire at the same time to acknowledge the zeal and interest Mr. MARRIOTT has shown at all times in the affairs of the Society, his many valuable contributions to the *Journal* and to the other publications of the Society during so many years, and also the courteous manner with which he has placed his knowledge and long experience at the service of observers in all parts of the country.

"JANUARY 1907."

[The Address was signed by all the Members of the Council.]

Mr. W. MARRIOTT said :—Mr. President—I scarcely know how to speak to-night, because this Address comes quite undeservedly. I should have very much preferred if the Council had let me go on my way, and not done anything of the kind ; but I recognise, however, the kind spirit prompting this presentation, and I shall prize the good feeling which has led the Members of the Council to give me this beautiful Address. I shall value it all the more because it contains two portraits, one of the founder of this Society, Mr. Glaisher, who was for some years my chief officer at the Royal Observatory, Greenwich, and the other that of Mr. Symons, who I consider was one of the greatest benefactors of this Society, and who was a very great friend to me and rendered me much valuable assistance. You speak, Sir, of the observations made over the country ; it was Mr. Symons who instructed me how to inspect stations, and I greatly profited by his advice. My ordinary work in the Society goes as a matter of course ; and I am always pleased and delighted to render what information I can, so as to be helpful to others. The new venture which the Society has recently undertaken of Lectures has certainly been an undertaking. I find it is serving its purpose in interesting people in Meteorology, and in inducing them to notice atmospheric phenomena. Since the scheme was started in October 1905 I have given 37 Lectures, and you may be interested in knowing that the attendance at them has been over 5000. The audiences have varied from 20 to over 500, the average being about 140. You will see that the Society has been the means of disseminating a knowledge of Meteorology to a considerable number of people. I thank you, Sir, and the Members of the Council very heartily for this kind expression of your esteem to myself.

ALTERATION OF BY-LAW 15.

Dr. THEODORE WILLIAMS proposed that By-Law 15 be altered to read as follows :—"Any Fellow may, on his election (the entrance fee being first paid), compound for all future annual payments by a single payment of Twenty-five Pounds, or at any subsequent period on the following scale (provided that there shall be at the time no arrears due by him to the Society), viz. : Fellows of ten years' standing and under twenty years', Twenty Pounds ; and Fellows of twenty years' standing and over, Twelve Pounds."

Dr. Theodore Williams, in moving the adoption of the altered By-Law, said that the compound subscription was decidedly below that of other Societies. It has therefore been put up to £25. But the composition has been graded, £20 at one time, £12 at another. It is thus hoped to smooth the way for Fellows who find a difficulty in keeping up the subscription of £2 every year.

It is hoped that, on the whole, this will add considerably to the funds, but it is chiefly done with a view to meet the suggestions that have been from time to time thrown out on this subject. It will be one of the few proposals which have been carried out to help the funds of the Society, which did a very great deal for a very small amount of money. It was almost astonishing to see the enormous amount of work done by our Society at a very small expense. If some of the Government Offices followed our example, we should find our taxes very much reduced.

Mr. J. W. **Forrester** seconded the Resolution, which was adopted.

Thanks to the Council and Auditors.

Dr. H. N. **Dickson** moved: "That the thanks of the Society be given to the Officers and the other Members of the Council for their services during the past year, and also to the Auditors." He said that there could be no doubt whatever, from the Report, that the Society was in a very flourishing condition. This was due to the assiduous attention devoted to the Society's interests by the Officers and Council during the year.

Capt. A. **Carpenter** said that he had very great pleasure in seconding the motion. He had heard with great pleasure the eulogy passed upon Mr. Marriott by the President. Mr. Marriott had said that the ordinary work went as a matter of course, but in his opinion it was a matter of good hard work and steady attention. A tremendous amount of work had been got through, and their thanks were very much due to the Officers and Council.

The Resolution was adopted.

Institution of Civil Engineers.

Capt. W. F. **Caborne** said that the very pleasant duty had devolved upon him of moving "That the thanks of the Royal Meteorological Society be communicated to the President and Council of the Institution of Civil Engineers for having granted the Society free permission to hold its meetings in the rooms of the Institution." Speaking from a personal knowledge extending over three decades, he knew that month after month and year after year that privilege had been accorded absolutely free of cost, a fact which called for the deepest gratitude. It had been said that gratitude was a sense of favours to come, but he utterly repudiated that definition, and maintained that in the present instance it meant sincere and hearty thanks for past benefits to the great scientific Institution which had so cordially and constantly welcomed the Society to its palatial home.

Dr. R. H. **Scott** seconded the Resolution.

The President wished to add only one more remark—how extremely fitting it was for them to meet in a chamber that contained the portrait of one of their early Presidents, Mr. Robert Stephenson. He also mentioned that one of the Fellows of the Royal Statistical Society had left £9000 towards a building fund for that Society, and suggested, if some day the Royal Meteorological Society were to be equally fortunate, that some combined effort might be possible to acquire or erect a house for the joint use of these Societies.

He wished to mention an excellent proposition made by one of the members of the Council, to have a Dinner in June after the afternoon meeting of the Society. During the summer months there was a large attendance of visitors and Fellows who were unable to come during the winter. The intention would be to hold the Dinner on or about June 19, at some convenient centre in London.

The Resolution was adopted.

PRESIDENT'S ADDRESS.

THE PRESIDENT then delivered an Address on "Weather in War Time" (p. 81).

Mr. R. INWARDS moved: "That the thanks of the Society be given to Mr. Richard Bentley for his services as President and for his Address, and that he be requested to allow it to be printed in the *Quarterly Journal.*" They had never had a President who had performed his duties with greater punctuality, dignity, and ability than the one who was about to vacate the chair. He thought that the Address should be printed in full, because it was interesting to the friends of peace in depicting so graphically the horrors of war, while it would often be referred to in the future even by military men, as it touched on so many points which were vital to the proper carrying on of warlike operations, in which the weather played so important a part. Every General in future must be a meteorologist. All present would wish that some permanent record of the appreciation in which Mr. Bentley was held should be presented to him engrossed on parchment, so as to be suitable for preservation in his valuable library at Slough.

Mr. H. MELLISH, in seconding the motion, said that the President's Address touched upon a new subject. The tacticians talked a great deal of the fog of war, but they did not seem to be much more successful in dispersing it than meteorologists in dispersing ordinary fogs. He hoped that British officers and meteorologists might be brought closer together in the future. He said that British officers had ample opportunities of studying the weather in out-of-the-way parts of the world; he thought that both naval and military men might get a good deal of information from Meteorology. It should be part of the duty of the General Staff to prepare notes on the weather, etc., of any part of the world where British troops might be stationed.

The Resolution was adopted.

THE PRESIDENT thanked Mr. Inwards and Mr. Mellish most cordially for their remarks regarding his effort to explore some fresh ground that evening, and also for the suggestion that some acknowledgment of his services on vellum might be drawn out. He wished, however, to be allowed to disclaim that honour; he had already the kind words and expressions of opinion confirmed by so many, perhaps too kindly and indulgent critics, which he would not soon forget, and they would take the place of what Mr. Inwards so kindly suggested. He was greatly interested in some of Mr. Mellish's remarks, because one was much struck by the few references in military works to the influence weather had on the great operations of war, and he hoped that some one later on might be found to tackle the subject more adequately.

ELECTION OF OFFICERS AND COUNCIL.

The Scrutineers then declared the following to be the Officers and Council for the ensuing year:—

PRESIDENT.

HUGH ROBERT MILL, D.Sc., LL.D.

VICE-PRESIDENTS.

RICHARD BENTLEY, F.L.S., F.R.G.S.
Capt. WARREN FREDERICK CABORNE, C.B., F.R.G.S., F.R.A.S.
EDWARD MAWLEY, F.R.H.S.
Sir JOHN WILLIAM MOORE, M.D., F.R.C.P.I.

TREASURER.

CHARLES THEODORE WILLIAMS, M.A., M.D., F.R.C.P., M.V.O.

SECRETARIES.

FRANCIS CAMPBELL BAYARD, LL.M.
HENRY MELLISH, D.L., J.P., F.R.G.S.

FOREIGN SECRETARY.

ROBERT HENRY SCOTT, M.A., D.Sc., F.R.S.

COUNCIL.

Bt.-Col. JOHN EDWARD CAPPER, R.E., C.B.
JAMES EDMUND CLARK, B.A., B.Sc., F.G.S.
Capt. MAURICE HARVEY CLARKE, F.R.A.S., F.R.G.S.
RICHARD HENRY CURTIS.
HENRY NEWTON DICKSON, M.A., D.Sc., F.R.S.E., F.R.G.S.
WILLIAM HENRY DINES, B.A., F.R.S.
FRANCIS DRUCE, M.A., F.R.G.S.
WILLIAM ELLIS, F.R.S., F.R.A.S.
Capt. MELVILLE WILLIS CAMPBELL HEPWORTH, C.B., F.R.A.S.
RICHARD INWARDS, F.R.A.S.
BALDWIN LATHAM, M.Inst.C.E., F.G.S.
WILLIAM NAPIER SHAW, M.A., D.Sc., F.R.S.

INSTALLATION OF NEW PRESIDENT AND NEW SECRETARY.

THE PRESIDENT, then turning to Dr. Hugh Robert Mill, stated that it gave him much pleasure to announce the information of his unanimous election to fill the President's chair, which became vacant that night. Dr. Mill would be the thirty-first occupant of that chair, which had been sat in by Stephenson, Glaisher, and Symons. They all knew how from very early days Dr. Mill had been interested in scientific matters, more especially in Geography, in which he had gained a name not only in this country but beyond the seas. The famous French geographer, M. Elisée Reclus, had spoken of him as being one of the most distinguished living representatives of Geography. It had fortunately happened that circumstances had brought Dr. Mill closer to them; Geography and Meteorology were in many ways allied. When Dr. Mill succeeded as head of the British Rainfall Organization, he had been brought intimately into touch with all meteorological matters. He had also not long ago greatly interested most of those present as an author in the vivid record he had given of South Polar Exploration. It was with very great pleasure that he, Mr. Bentley, handed over to Dr. Mill the insignia of office, and also expressed to him the thanks of the Society in undertaking the duties of the chair, as they well knew that there were many other and pressing claims upon his time.

The President added that Dr. Mill's succession to the Presidential chair had created a vacancy in the office of one of the Secretaries. Mr. Mellish had kindly accepted the duties and responsibilities of the post, and it would give them all much pleasure to see him sitting in the Secretary's place at the Council table. His Nottinghamshire meteorological statistics were a most carefully drawn up and valuable addition to our weather records, and his recent services on the Finance and Reorganisation Committee were in the memories of all.

Dr. H. R. **Mill** said that he felt his appointment to this responsible position as the highest honour. To come after those great names to which Mr. Bentley had referred was an inspiration and an encouragement; but to come immediately after Mr. Bentley himself was an honour tinged with a feeling of despair, because of the admirable manner in which he had conducted the business of the Society, and the genial dignity with which he had filled the chair. Though he could not in this way be a worthy successor to Mr. Bentley, Dr. Mill yet felt some confidence in accepting office, because he was sure of the co-operation of the Fellows of the Society, and the brotherly help of the Council in everything that he might try to do for the Society. It was a great matter that the body of Fellows themselves were in thorough sympathy with the work of the Council; during all the time he had belonged to the Society, he had known of no single instance of the slightest friction between the Fellows and the Council, and he hoped that this would always continue, because such a state of things was absolutely essential to carrying out the work of the Society. With regard to Mr. Bentley's remarks about his connection with Meteorology, Dr. Mill said that his scientific interests had been from the first mainly meteorological, and his excursion into Geography might almost be regarded as a temporary digression. His first scientific paper, read to the Royal Society of Edinburgh in 1883, dealt with a series of observations on the Rainband in the spectrum of Sunlight; and the first scientific instrument he attempted to make as a boy was a rain-gauge, which would certainly not pass muster in Camden Square at the present time. It might not be inappropriate to refer to what seemed to have been a portent, if not a forecast. When he first came to London he arrived at Euston somewhat sooner than expected, and went for a walk at random, without a map of London, which proved at least that at that time he was no geographer. His eye was caught by the name "Camden Square," and knowing that Mr. Symons lived there he walked along till he found No. 62, looked at it with some feeling of disappointment on account of its modest appearance, and passed on. A few days later Mr. Marriott introduced him to Mr. Symons, who was his friend from that time onward.

February 20, 1907.

Ordinary Meeting.

Dr. **Hugh Robert Mill**, President, in the Chair.

John L. Adlercron, Hollyhurst, Burstow, Horley;
George Thomas Derry, The Elms, Sutton;
William Henry Matthews Jones, Leyden Villa, Chester;
Capt. **George Michael Keane**, H.M.S. *Diana*, Mediterranean Station;
John M'Ewan, Carisbrooke, Enfield;
Arthur Mudd, 19 Cherry Road, Chester;
Ramchundra Nursey, Kaloopur Post, Ahmedabad, India; and
Abraham Buckley Ogden, Urmston, Manchester,
were balloted for and elected Fellows of the Society.

The President announced that he had heard with great pleasure that a Fellow of the Society, Mr. A. L. Rotch, had been appointed Professor of Meteorology at Harvard University. They were in the habit of saying, on hearing of the creation of such chairs in American and foreign universities, that they did things better abroad than at home; and it was consequently with the greatest satisfaction that they received the news of the co-operation of the University of London also in the teaching of Meteorology. Some little time ago, at the suggestion of Captain Wilson-Barker, this Society entered into communication with the University regarding the subject. The University had now instituted a Readership in Meteorology, and had appointed Dr. Shaw as the first Reader. Dr. Shaw was to begin this week at University College, Gower Street, a course of five lectures on "Dynamical Meteorology," for attendance at which no fee was charged. These would certainly be found extremely valuable and interesting. He had a further gratifying communication to make concerning the higher study of our science. Through the kindness of an anonymous donor (who he understood was Prof. Schuster), a Readership in "Dynamical Meteorology" was to be founded at one of the British universities, to be selected when a Reader possessed of the requisite qualities was forthcoming. The duties were not only to lecture on Meteorology, but to conduct meteorological research. Full particulars could be obtained from the Director of the Meteorological Office, and the appointment would be made by the Meteorological Committee. The President concluded by remarking that the telephone had now been installed at the offices of the Society.

The following communications were read:—

1. "REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR 1906." By EDWARD MAWLEY, F.R.Met.Soc., V.M.H. (p. 139).

2. "THE METRIC SYSTEM IN METEOROLOGY." By RICHARD INWARDS, F.R.A.S. (p. 165).

CORRESPONDENCE AND NOTES

Lectures on Meteorology.

During the past three months Mr. William Marriott has given Lectures on Meteorological subjects, in connection with the Society's scheme for diffusing a knowledge of Meteorology, at the following places:—

January 15.—Oatlands Congregational Church, Uxbridge Road.
February 6.—British Sea Anglers' Society, Fetter Lane.
" 9.—Ealing Scientific and Microscopical Society.
" 18.—Glasgow and West of Scotland Amateur Photographic Association.
March 13.—Literary and Scientific Institution, Kendal.

Meteorological Club.

The Members of the Council of the Royal Meteorological Society have been accustomed to dine together before the evening Meetings of the Society. It has been thought that some other Fellows might like to join the Council in these social gatherings, and so "The Meteorological Club" has been formed. The object of the Club is to promote the usefulness of the Royal Meteorological Society by affording opportunities to Fellows for dining together informally before the Meetings and encouraging conversation on subjects of meteorological interest.

The rules of the Club are as follows:—

The President of the Royal Meteorological Society, or his substitute for the time being, shall be the Chairman of the Club Dinners, and the Assistant Secretary of the Society the Honorary Secretary of the Club.

The Membership is limited to Fellows of the Royal Meteorological Society. The Officers and Council of the Society are *ex-officio* Members of the Club.

New Members may be proposed by any Member, and the names of Members proposed shall be circulated to all the Members of the Club, and the election will take place at the next following Dinner if no objection is taken.

Any Member may introduce one guest to any Dinner.

Each Member shall pay an Annual Subscription of 2s. 6d. to defray the expense of printing and of forwarding intimations of the Dinners.

The Dinners take place in the Westminster Palace Hotel, Victoria Street, at 6.30 punctually before the evening Meetings of the Society. The charge for the Dinner, without wine, is 3s.

Members proposing to dine or to introduce a guest must intimate their intention to do so to the Hon. Secretary not later than the day previous to the date of the Dinner.

No alteration of these rules shall be made except at a general meeting of the Club of which at least seven days' notice shall have been sent by post to every Member specifying the alterations proposed.

Observations of Upper Clouds in New Zealand.

Owing to very serious illness I have had to retire from my profession and also drop all my Meteorological work, which I have carried on here for the past twelve years. I am now, with assistance, collecting the work done.

I regret that I have not so far collected the Upper Cloud Observations extending over a period of eleven years. I append the observations for the three years 1902-1904. I had these collected on the return of the British Antarctic Expedition for the purpose of comparison with Lieut. Royd's Upper Cloud Observations. Capt. Colbeck was desirous of having my observations, but illness has upset all my arrangements. I hope, however, soon to have the eleven years' Upper Cloud work properly tabulated.

I am sure you will find the result interesting, and, so far as I know, little or nothing has been done in this branch of meteorology in Australasia. In fact, in New Zealand there is little encouragement given. The late Premier, Mr. Seddon, was Minister in charge of a number of Departments, including the Marine, but his sole interest was in what concerned the working man. I certainly got considerable assistance from Mr. Seddon in my meteorological work, but I felt it was always a personal favour, and not due to any interest he had in the subject.

Barometrical records were sent to Capt. Edwin of the Marine Department, whilst the rainfall was dealt with by the Museum authorities; of course the result was a muddle. After long and persistent agitation, I have at last induced them to transfer the Rainfall to the Marine Department; also to establish more third-class Stations. We boast of the climate of New Zealand, yet we have absolutely no data with which to back up our assertions. The Medical Association are giving me loyal support in urging the necessity for systematical observations as to Climatology. I have got a number of the State School teachers interested in Nature Study, including Phenology, Rainfall, Temperature, etc., and two of our Education Boards are now providing their schools with thermometers, rain-gauges, etc. So that altogether, with awakened public interest and Government and Education Boards' support, the prospects are brighter.

The Nephoscope was used in all observations.

Upper Clouds and Directions, for years 1902 to 1904 (inclusive), as made at Kaikoura, Marlborough, New Zealand, at 9 a.m., situated 10 miles south of Kaikoura Ranges, the altitude of which is 8000 ft. Latitude, 42° 26′ 30″ S. Longitude, 173° 45′ E. Height above sea-level, 50 ft. Distance from sea, one-quarter of a mile.

Upper Clouds.—Ci., Ci.-St., Ci.-Cum.

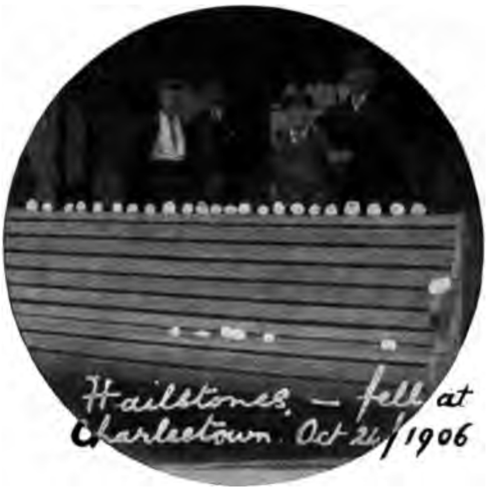
Out of 224 observations made during the three years the drift was :—

From S.W.	on 87 occasions.	From S.E.	on 3 occasions.
„ N.W.	„ 62 „	„ N.E.	„ 2 „
„ W.	„ 60 „	„ N.	„ 1 „
„ S.	„ 9 „	„ E.	None.

John St. C. Gunn, M.B., C.M., Bloomsbury, Kaikoura, New Zealand, December 17, 1906.

Hailstorm at Charlestown, Natal, October 24, 1906.

I give you an account of how the weather was previous to the storm, etc. In the first place a few minutes elapsed between the taking of the photograph and when the hail fell, as the camera had to be fetched from the house and brought down to the railway station, and the hailstones balanced on the back of the seat, so they melted somewhat. One of the railwaymen scaled one of the stones, and it weighed 1¼ lbs. This stone was picked up by him at Langs Nek, from which direction the storm came. Most of the stones were larger than turkey eggs, and one we measured 5½ ins. by 4½ ins. in circumference.



The day of the storm, October 24, was not very bright but rather overcast ; and in the afternoon the clouds seemed to be moving in all directions and very quickly. About 2 p.m. some very large white misty clouds seemed to make for one direction, viz. from Langs Nek to Charlestown, and a terrific noise was heard in that direction about 20 minutes before the hail fell. The people could not make out what the noise was, and I and my friends said it must be the reservoir (or dam) in the hills which had burst, and the water rushing down must account for it. At last, however, the noise became louder, and a whitish mist was seen coming towards us, which was of course hail. The stones first fell in ones and twos, and then heavily ; and the people thought the world was at its end. The storm continued for about 15 to 20 minutes, and could be seen to go round between the hills. From all accounts the storm was only local, the hail only falling at Langs Nek and Charlestown. Nothing was known about it in the next town, viz. Volksrust, until they heard it from the Charlestown people. Never has such a storm been seen here before, and there is a great call for photographs. In fact, in Charlestown I could not print photographs quick enough to cope with the orders.—Thos. E. Allerton, N'klandhla Hotel, Zululand, *January* 21, 1907.

Evaporation from the Soil.

The following are the results of some observations made at Tenbury, Worcestershire, and at Exmouth, Devonshire, between 1891 and 1898, to try to find out the quantity of water given off in vapour by the earth during the day and year. The place of observation was a lawn mowed by machine, and the times, every four hours during the twenty-four.

The apparatus used was a cylindrical zinc pail 8⅝ inches in diameter and about the same in height, and a collar 2½ inches deep into which the pail fitted easily. Inside the collar were three loops so arranged that when the collar was placed on the grass and the pail put in it, the pail could enter only an inch and was supported so as not to touch the grass. The pail had a cover with a pad of felt two inches thick fastened to it, and the pail was wrapped in two inches thickness of felt. In using the apparatus a thin zinc plate 8⅝ inches in diameter was placed in the collar, and the pail put on top of it half filled with a freezing mixture.

The idea was to freeze the vapour rising from the earth on to the zinc plate, and then to weigh it, and so find the quantity of water given off per square foot. A good many observations were made, but they were disappointing, and not more than a few were what could be called successful. If the freezing mixture was too strong, the vapour froze on the grass before reaching the plate; if it was not strong enough, it covered the plate like dew and some might drop off on to the grass again. It was better, however, to try for dewy plates short of freezing than for frosted ones, as the former could be managed with care; but altogether the process was disappointing in the best of cases, and a change of weather often spoilt half-a-day's work.

The general results, which are all that are worth mentioning, are as follows. With frozen ground in February, the water condensed upon the plate from a square foot of surface was sometimes as little as five minims in the day; with a thaw it would rise to seventy-three minims. In September it sometimes amounted to a hundred and seventy-one minims in the day. There was most evaporation between four and eight o'clock in the evening, and least between four and eight o'clock in the morning. The grass had a good deal to do with the amount evaporated; bare ground gave out a good deal less.—W. F. Badgley, Devizes, March 17, 1907.

Meteorological Work at the Royal Observatory, Greenwich, 1906.

The meteorological observations by eye, and by self-recording instruments, have been maintained as usual, and the special observations of clouds on selected days in each month have been continued at the request of the International Balloon Committee, a Fineman nephoscope having been used for this purpose.

Daily reports have been issued as in previous years, weekly meteorological returns furnished to the Registrar-General, monthly returns of temperature, rainfall, and sunshine to the Society, and quarterly reports to the Meteorological Office.

The temperature of the air ranged between 94°·3 on August 31, and 19°·8 on December 30. In only two previous years, 1895 and 1898, when the maximum for the year occurred in September, had it been so late as August 31 in the Greenwich registers, the nearest approach having been in 1883, when the maximum occurred on August 21. Moreover, in 1906 the minimum for August, 44°·1, was registered on the 29th, so that between the 29th and 31st the range was greater than 50°—a sudden change unprecedented in the Greenwich results. Again, in no previous year, except on September 7, 1868, and September 8, 1898, had a temperature of 90° been registered at Greenwich in September; but in 1906 the maximum exceeded 90° for each of the first three days of the month, that of 93°·5 on September 2 being the highest recorded in September at Greenwich, thus making with August 31 four consecutive days with maximum reading above 90°. Never before in the Greenwich records had four such days occurred consecutively, though there were three such in 1868, July 20, 21, and 22; in 1876, August 13, 14, and 15; and in 1893, August 16, 17, and 18. An unusual feature of this very hot spell was the very low humidity, less than 50 per cent each day, and the almost entire absence of cloud. The mean temperature for the year was 50°·5, being 0°·9 above the average for the 65 years 1841-1905. Four of the months, January, August, October, and November, showed mean temperatures well above the average, by 3°·8, 3°·1, 4°·3, and 3°·0 respectively; December, however, being 2°·2 below the average.

The duration of sunshine recorded in the year was 1734½ hours, the sun having been above the horizon for 4458½ hours. This duration is the greatest recorded at Greenwich, being 30 hours greater than that of 1899, and 232 hours greater than the average for the 10 years 1897-1906, during which period the record has been made with the same glass ball in the same position. The greatest actual duration on a single day was 14·9 hours on June 26; but on several occasions a higher percentage was registered, the trace being within an hour of the total interval between sunrise and sunset on March 7, April 4, August 22 and 31, and September 2, and practically also on September 1 and 25. The actual defect was only 40 minutes on August 22, and 38 minutes on March 7; the trace on the former date being more than 96 per cent of the conventional "total possible." The duration of register in October, 128 hours, was the longest known at Greenwich during the 30 years of regular observation. There were during the year 62 days with no sunshine registered, none of these occurring in July, one each in June, August, and September, two each in April and October, and three in May, which was relatively the dullest month in the year.

The highest reading of the solar radiation thermometer with blackened bulb *in vacuo* was 153°·9 on August 1, and the lowest reading on the grass was 15°·2 on April 15, an unusual date for the lowest reading. The difference between the "highest in the sun's rays" and the "lowest on the grass" exceeded 100° on 32 days, reaching 115° on August 1.

Rain fell on 161 days in the year to the total amount of 24·737 ins., being 0·199 in. greater than the average for the 50 years 1841-1890, and 0·615 in. greater than the average for the 65 years 1841-1905. The driest months were April, with 0·672 in., and July, with 0·414 in; and the wettest, November, with 4·114 ins., and January, with 3·713 ins. The low rainfall in July stands just between the two wettest days of the summer, 1·900 in. falling on June 29, and 0·790 in. on August 2; other heavy falls were 0·793 in. on May 20, 0·922 in. on October 30, and 1·277 in. on November 8. Two "absolute droughts" occurred during the year—one of 18 days, March 27 to April 13, and one of 14 days, June 30 to July 13, immediately following the downpour of June 29, the heaviest recorded at Greenwich on any day in June.

The greatest recorded pressure of the wind was 19·4 lbs. to the square foot on January 18. The greatest daily velocity was 767 miles on January 6, and the least 54 miles on November 13. The greatest hourly velocity was 50 miles, from 9 to 10 a.m. on January 6. The total movement for the year was 109,007 miles, the greatest monthly movement being 12,811 miles in January and the least 6875 miles in September.

Parhelia were observed on May 3, October 10, and October 18.

In addition to the regular work for the year, time has been found to prepare and issue Part IV. of the *Reduction of Greenwich Meteorological Observations* containing tables of air temperature 1891-1905, in continuation of those in Part III.

for the fifty years 1841-1891, which was published in 1895.—W. H. M. CHRISTIE, March 25, 1907.

Meteorological Work at the Radcliffe Observatory, Oxford, 1906.

The usual meteorological observations and automatic registrations have been maintained and the results forwarded regularly as heretofore to the Meteorological Office (by daily telegram), the Registrar-General, the Thames Conservancy, the Metropolitan Water Board, local newspapers, public and sanitary authorities, and numerous private inquirers.

During the year 1906 the five underground platinum thermometers were in daily use. At the request of the Director of the Meteorological Office, daily comparisons have been made between the platinum thermometers and two ordinary mercurial thermometers of Symons' underground pattern at depths of 6 inches and 3 feet 6 inches.

All the automatic instruments have worked well during the year.

The following are the chief characteristics of the weather noted at Oxford during the year 1906 :—

The mean reading of the barometer (reduced to 32°) was 29·750 ins., which is 0·024 ins. higher than the mean for the preceding 51 years. The highest reading, 30·448 ins. occurred on January 23, whilst the lowest was 28·614 ins. on February 10. The mean temperature of the air for the year was 50°·0 or 1°·2 above the mean for the preceding 78 years. The maximum temperature was reached on two successive days, September 1 and 2, viz. 91°·6. The minimum in air was 21°·5 on December 26, whilst the lowest reading of the thermometer exposed on the grass was 12°·7 on December 26.

Monthly differences from the corresponding means for the preceding 78 years for air temperature (4 feet above the ground) are :—

	°		°		°
January . .	+4·2	May . .	-0·4	September . .	+2·5
February . .	-1·4	June . .	0·0	October . . .	+3·4
March . . .	-0·1	July . .	+1·0	November . .	+2·9
April . . .	-0·4	August .	+3·8	December . .	-1·8

Bright sunshine was recorded during 1669 hours, or 213 hours in excess of the mean for the preceding 25 years. The monthly differences from the mean are indicated in the following table :—

	hours.		hours.		hours.
January . .	+21	May . .	-65	September . .	+57
February . .	+21	June . .	+27	October . . .	-15
March . . .	-5	July . .	+45	November . .	-6
April . . .	+54	August .	+64	December . .	+15

Rainfall on the ground amounted to 24·229 ins., being 1·8 ins. less than the mean for 91 years. The number of "rainy days" (0·01 in. and over) was 143. Divergences from mean monthly totals from 91 years' observations were :—

	ins.		ins.		ins.
January .	+1·576	May . .	-0·213	September . .	-1·617
February .	-0·042	June . .	+1·123	October . . .	+1·297
March . .	-0·307	July . .	-1·508	November . .	+0·894
April . .	-1·415	August .	-1·496	December . .	-0·109

ARTHUR A. RAMBAUT, Radcliffe Observer, March 5, 1907.

Daily Weather Report.

The Meteorological Office on January 1, 1907, issued the *Daily Weather Report* in a new and improved form. The following note on the subject appeared in *The Times* of January 21 :—

"An important addition has been made to the list of stations from which meteorological reports are received, by the inclusion of observations from Seydisfjord, in Iceland, and Thorshavn, in the Faröe Islands. Telegrams from these stations are at present received twice daily, in the morning and evening, and as the evening report includes observations made in the afternoon a complete sequence of information is available for comparison with that received from various parts of Western Europe at the three ordinary hours of observing. The value of these additions to the daily report can scarcely be over-estimated. During the prevalence of certain weather types, information from the Icelandic region should afford timely warning of the approach of many of the storm systems which sweep down upon these islands from the northward or north-westward. Beyond and above this the reports are likely to supply at all times valuable information as to the distribution of barometrical pressure over the upper portions of the Atlantic, and in this way to aid very materially in the work of weather forecasting. On the last page of the *Daily Weather Report* a space is now allotted to wireless telegrams. None of these have as yet been actually received, but we understand that negotiations are in progress between the Admiralty and the Meteorological Office for the supply of such information at an early date from the ships of His Majesty's Navy. In order that the additional data may appear *in situ*, the area of the synoptic maps which appear in the report has been enlarged, so as to include practically the whole eastern half of the North Atlantic, the map devoted to barometer and winds extending sufficiently far to the westward to take in the Azores, from which islands reports have been received for some few years past. In addition to the maps for the current day a smaller chart has hitherto been given showing the distribution of pressure and wind for 8 a.m. on the previous day. This is now supplemented by a chart giving similar information for 6 p.m.—a valuable addition, enabling the student to follow intelligently the sequence of events from the morning of one day to the morning of the next."

Société Astronomique et Météorologique de Port-au-Prince.

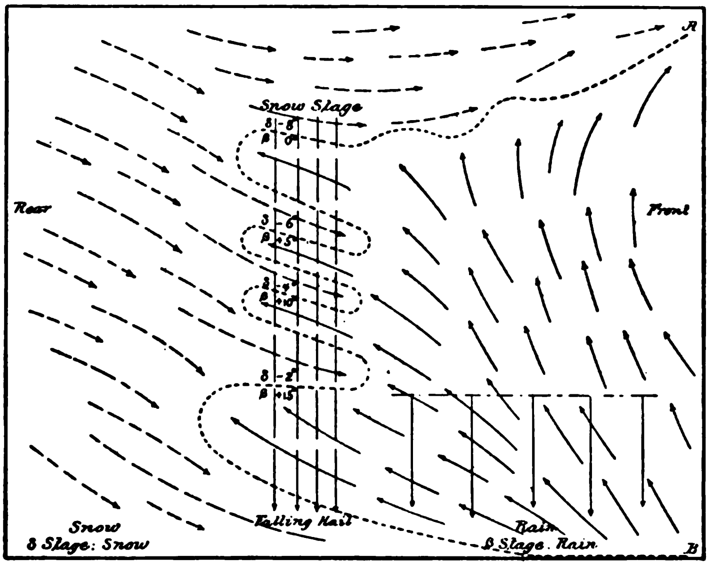
This Society was founded on January 30, 1905, and now has 53 active members. The President is Dr. D. Destouches, and the Secretary Prof. H. Heraux. The Society has just published its *Bulletin Annuel* containing the results of the meteorological observations made at its Observatory during the year 1906.

Measurement of the Height of Clouds by Reflectors.

Following the erection, on the Schwarzenbergplatz, Ringstrasse, of the "Leuchtbrunnen" (light-fountain), a new, simple, and altogether exact method has been arrived at in Vienna for determining the height of the clouds above the surface of the earth. The illumination by electric reflectors of the high-jet fountain is effected from beneath. When the cone of light, ascending perpendicularly, strikes the cloud, it imprints on it a light spot. Dr. J. Rehden, assistant at the Vienna Astronomical Observatory, hitherto known by his feats in the field of astrographics, noting the fact, bethought him to measure the angle of elevation (a) of the light-spot on the clouds, as seen from the astronomical observatory. The distance (d) of this point of observation from the source of light (the Leuchtbrunnen) being exactly known, the height (h) of the light-spot, *i.e.* of the clouds, becomes readily determinable ($h = d \tan a$). The first measurements were instituted from June 14 to 24, and the results showed the clouds to be at heights of from 5000 to 33,000 ft. By these experiments it was found that sometimes under perfectly clear weather, on projecting the cone of light aloft, the light-spot appeared as an indication of the existence of a layer of moisture. As is well known, the clouds often lie in layers at very unequal heights one above another, such as the naked eye itself distinguishes. The first observation by reflectors showed the under layer to be at 5100 ft., the upper at 8400 ft. A second gave the lower layer at 9800 ft., the higher at 33,000 ft. Finally, a third observation showed three layers at heights respectively of 6200, 12,500, and 14,000 ft. The new method surpasses in exactitude the most trustworthy of the methods hitherto applied, namely, the photogrammetric, determining, as it does, the altitudes in question with positive certainty. It is hoped to start a systematic course of such observations in other parts of the earth as well. There is no doubt that not only for science, but also for practical weather forecasts, such observations will prove highly serviceable.—*The Geographical Journal*, February 1907.

Formation of Hailstones.

Prof. F. H. Bigelow has been contributing to the U.S. *Monthly Weather Review* a series of articles entitled "Studies on the Thermodynamics of the Atmosphere." In the Part for November 1906 he deals with the subject of hail. He points out that there are many theories regarding the mode of formation of hailstones, in each of which there is probably an element of truth. None of them can be said to be entirely satisfactory, and yet it is very likely that nearly all of the assigned natural causes and effects generally operate in producing the phenomena. The two principal facts to be accounted for are, (1) the presence of the cold which causes the sudden stiffening of the water drop at undercooled temperatures, and (2) the alternation of snow and water materials in the successive layers. In the sudden cooling of the water drops there is evolved a considerable amount of latent heat, and the cold must be present to such an extent as to overcome the restraining effect of this latent heat, and yet produce cooling as by a shock of the molecular material in the water. After examining the theories which have been proposed for the explanation of the growth of hailstones, viz. :—(1) the oscillation theory ; (2) the orbital theory ; (3) the upward current theory ; and (4) the electrical attraction theory, Prof. Bigelow proceeds to examine the subject from a new point of



Stratification of β and δ stage in a cloud with hail.

view, which seems to him to offer certain advantages over the other theories, and to embody the best points of them all. This he calls the "Stratification theory." It happens that a hailstorm cloud, which is merely an intense form of thundercloud, really consists of two component portions separated from each other by isothermal surfaces inclined forward from the vertical. On the front side the air is much warmer than on the rear side, and along the line of separation the contour is strongly stratified by the mutual interpenetration from opposite directions of layers having different temperatures. The accompanying diagram roughly illustrates the idea. Such storms begin in consequence of the transportation of cold air into a region of warm air, and in many cases the difference of temperature amounts to as much as 20° F. The tendency for such masses of air at different temperatures is to mix intimately and irregularly in order to restore the thermal equilibrium as rapidly as possible. The cold air is carried forward in the high levels, and like a sheet overflows the warmer lower layers, as indicated by the first formation of clouds of the cirrus type, which later change into alto-cumulus and alto-stratus types.

The body of warm air tends to rise and interpenetrate the cold air in a congested circulation, including numerous minor whirls and small vortices. On the western side of the column of rising warm air the tendency to stratification of the warm and cold layers in horizontal directions is very pronounced, the sheets of different temperatures penetrating strongly at a series of intervals in elevation, so that they lie over each other on a given vertical in succession which may be repeated many times. The boundary between the β-stage and the δ-stage, or the course of the γ-stage, is therefore folded upon itself several times in a vertical direction.

For example, we may suppose that the temperatures are arranged in some such manner as the following :—

Let β = +15° C. (59° F.) and δ = −2° C. (28°·4 F.) in the lowest fold.
Let β = +10° C. (50° F.) and δ = −4° C. (24°·8 F.) in the second fold.
Let β = + 5° C. (41° F.) and δ = −6° C. (21°·2 F.) in the third fold.
Let β = + 0° C. (32° F.) and δ = −8° C. (17°·7 F.) in the fourth fold.

The temperatures in the β stage fall off more rapidly than in the δ stage, and the difference between them diminishes with the height.

The snow nucleus, starting from a great height, meets the water carried aloft in the warm strata, is coated with the drops, which are chilled by its lower temperature and frozen in irregular semicrystalline forms. The vertical current at even moderate velocities is able to carry up all the water contents in the form of drops, and they are injected as it were sideways from a fountain into the higher strata. The snow nucleus is therefore simply exposed to a spray of water drops, brought from the lower strata, where high vapour contents prevail, because of the warm air occupying the lower levels before they were disturbed by the overflowing anticyclonic cold. The cold nucleus, therefore, suddenly condenses a layer of clear ice, or ice and snow, when mixed by the minor vortices and horizontal rolling of the air. The small hailstone then falls by gravity through successive stratifications of the snow and rain stages, it grows on the underside by special accumulations there, and finally reaches the ground, having received as many layers as there are distinct horizontal minor stratifications. The undercooling takes place chiefly in the highest stratifications, and ice or snow crystals are found deposited in the inner layers of the hailstone. The under cooling diminishes with the descent, so that the outer layers are watery or simply opaque.

There evidently exists a series of small horizontal rolls produced by the dynamic action of the interflowing sheets, where the mixture of air at different temperatures is facilitated by drawing it out into thin ribbons, as in ordinary cyclonic circulations. The lowest cold stratum flows forward on the ground, producing the squall of cold air that precedes the rainfall. Prof. Bigelow in another part of his papers has a diagram of approximate position of isotherms and isobars (not reproduced here) which shows that this distribution of the air current is the probable one, allowing for the minor configurations on the edges of the mixing masses. The isobars show that at the sea-level the air flows forward, but in the upper levels it flows backward at the time of the hailstorm. The isotherms show that there is an excess of upward velocity at the line of separation, and also that the flow is backward in the higher levels. The production of lightning discharges under these conditions, especially in the region where the cloud is serrated as to temperatures, is evidently to be anticipated, in consequence of the rapid changes occurring in the thermal conditions and the water contents. The hailstones may therefore be heavily charged with positive electricity, or even with negative electricity, under these circumstances, and the fallen hailstones may exhibit electrical states by no means uniform from storm to storm.

It is desirable that numerous computations be made on the data that may be obtained from the surface observations in thunderstorms and in hailstorms, with the view of transforming our inferences regarding the thermal operations going on in the midst of such clouds into more definite knowledge. The formulas and the tables employed in this paper are satisfactory, and it is possible to accomplish much by using only our surface observations. It is, however, very important to supplement such studies with the actual observations in the clouds by balloons and kites.

Readership in Dynamical Meteorology.

It was announced in *The Times* of April 26, that the Meteorological Committee have appointed Mr. Ernest Gold, M.A., Superintendent of Instruments in the Meteorological Office, to the Readership in Dynamical Meteorology established for three years from October 1, 1907.

RECENT PUBLICATIONS

A First Report on the Relations between Climates and Crops. By CLEVELAND ABBE. U.S. Department of Agriculture. Weather Bureau. Bulletin No. 36. Washington, 1905. 8vo. 386 pp. $1.50.

This Report is not designed as an original investigation, but merely as a summary of the views of the best experimentalists and observers, so far as those have been published up to 1891. A continuation of this study, bringing the subject up to date, is contemplated. The work has been prepared with the idea that it will be especially useful to the teachers of the agricultural colleges and the investigators of the agricultural experimental stations.

The book is divided into four parts.

Part I. treats of "Laboratory Work, Physiological and Experimental," and is divided up into nine chapters, which deal with General Remarks ; Germination ; Temperature of the Soil ; Influence of Sunshine on Assimilation and Transpiration ; Methods of measuring direct or diffuse Sunshine as to Intensity or Duration ; Moisture of the Soil ; and Miscellaneous Relations.

Part II. treats of "Open-Air Work—Experience in Natural Climates," and includes three chapters which deal with Phenology, and the Relation of Special Crops to Special Features of Climate and other Influences.

Part III. is devoted to the subject of "Statistical Farm Work," and deals with the crops and climates of the United States.

Part IV. contains a Catalogue of periodicals and authors referred to in the work, and a full general Index.

Beiträge zur Klimatologie Thüringens. Nachtrag betreffend die Windverhältnisse von Erfurt. Von FRIEDR. TREITSCHKE. Berlin, 1906. 4to. 16 pp.

This gives the results of the hourly records of the winds in Erfurt for the seventeen years 1888-1904, as obtained by Friedrich Treitschke. As that gentleman died in 1905, the work has been completed and published by Dr. G. Hellmann.

Climatology of the United States. By ALFRED JUDSON HENRY, Professor of Meteorology. Prepared under the direction of WILLIS L. MOORE, Chief U.S. Weather Bureau. U.S. Department of Agriculture. Weather Bureau. Bulletin Q. Washington, 1906. 4to. 1012 pp. and 33 plates. $10.00.

The primary object of this work is to present in form for easy reference comparative statistics for the different portions of the United States. The statistics used cover the period 1870-1903.

The work is divided into two parts. The first part, which is by Prof. Henry, deals with the broader features of the climate of the United States ; and the second part contains the reports by the Section Directors on the climate of the respective States, and these give the monthly, seasonal, and annual means at certain selected stations.

Prof. Henry points out that the determining factors of the climate are chiefly latitude, the relative distribution of land and water, the elevation of the general land surface above the level of the sea, and the prevailing winds as controlled by the movement of cyclones and anticyclones. He gives instances of various types of weather, which he illustrates by a number of maps.

It appears that the highest temperature ever recorded in the United States was 122° in Death Valley, California, in the summer of 1891. A minimum temperature of 65° below zero was registered at Fort Keogh, Mont., in January 1888.

This work is a valuable contribution to the climatology of the United States.

Das Wesen der Cyklonen und ihre besonderen Erscheinungsformen, als Hagelwetter und Gewitter. Nebst einem Anhange über das Wetterschiessen. Von A. STREIT. Wien, 1906. 6 + 125 pp. 4to.

The author deals with both cold cyclones and warm cyclones and the manifestations accompanying them. He also speaks of the formation of hail.

Les Bases de la Météorologie Dynamique. Historique—État de nos Connaissances. Par M. le Dr. H. HILDEBRAND HILDEBRANDSSON et M. LÉON. TEISSERENC DE BORT. 3me livraison. Paris, 1907. 8vo. 44 pp. and 62 plates.

The publication of this part, which has been greatly delayed, deals with the mean distribution of meteorological elements at the surface of the globe. The authors give a succinct historical account of the principal works which have led to the construction of charts indicating the distribution at the surface of the globe of the meteorological elements. They give specimens of the charts of different periods to indicate the stages by which the existing state of our knowledge has been reached.

METEOROLOGICAL LITERATURE.

The following titles of papers bearing on Meteorology have been selected from the contents of some of the periodicals and serials which have been received in the Library of the Royal Meteorological Society. This is not a complete list of all the published meteorological articles, but only shows those that appear to be of more general interest.

For a full Bibliography the reader is referred to the *International Catalogue of Scientific Literature.*

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THE EXPLORATION OF THE AIR.

By MAJOR B. F. S. BADEN-POWELL.

[Abstract of a Lecture delivered before the Royal Meteorological Society, March 20, 1907.]

THE atmosphere forms a vast ocean above us, an ocean but little explored. We crawl about the ground like crabs on the bottom of the sea. We make our meteorological observations down on the ground, ignorant of all that is going on in the midst of that great expanse of air above our heads, where the clouds hang about, where the rain and the hail are formed, where the lightning-flashes have their origin. On the wall is a diagram showing the relative heights of mountains, clouds, balloon ascents, and even buildings. How insignificant in comparison do the latter appear! We look up at the cross on St. Paul's Cathedral towering up into the sky. We consider such a point as exalted enough from which to observe the mechanism of the atmosphere, yet as compared to the aerial ocean it is but as a pin stuck in the carpet in comparison to the air of a room from floor to ceiling.

If all the clouds in the sky were suddenly solidified in their various shapes and different elevations, what vast realms of unexplored territory there would be! But even though not solid land, there is still plenty to explore in these regions of ever-changing cloudland. If we can mount up among them, we can ascertain the temperature, the humidity, the pressures, the electrical effects, and many other points on which we are at present very ignorant; and by such means we may be able to find out something about the laws of our weather which are at present such a perplexing mystery.

There are two classes of people interested in the exploration of the atmosphere: (1) The meteorologists, who study it chiefly to find out about the weather; and (2) the inventor, who would utilise it as a highway of travel. But these two are by no means rivals. The attainment of their objects will be of mutual assistance to one another. The aerial navigator will want to know all about the currents and the conditions of the air, while the meteorologist will derive the utmost benefit from the ability to visit any parts of the atmosphere he may wish to study.

There are three means now at the service of man by which he may ascend into these desirable regions, or may send up self-recording instruments to probe the mysteries of the skies, viz. (1) balloons, (2) kites, and (3) flying machines.

BALLOONS.

The balloon, at the time of its invention (over 120 years ago), was hailed with acclamation as promising the conquest of the air to man, yet it is now realised that this cumbrous and delicate apparatus is not capable of much practical application. It is nevertheless useful (1) as an observatory for scientific investigation, (2) as a means of reconnaissance in war, and (3) as a most agreeable way of spending an hour or two in blissful peace and sublimity. As regards ascents for the scientific exploration of the air, we may remember that Glaisher in 1862 ascended 37,000 ft.—nearly 7 miles. The illustration shows the arrangement of the car on this occasion, Mr. Glaisher sitting among his instruments, and Coxwell beside the grapnel. Though their height was not very well determined, Berson and Suring in 1901 certainly attained a height of about 34,800 ft. Opposite is a photograph of my old balloon *Eclipse* during inflation (Fig. 2).

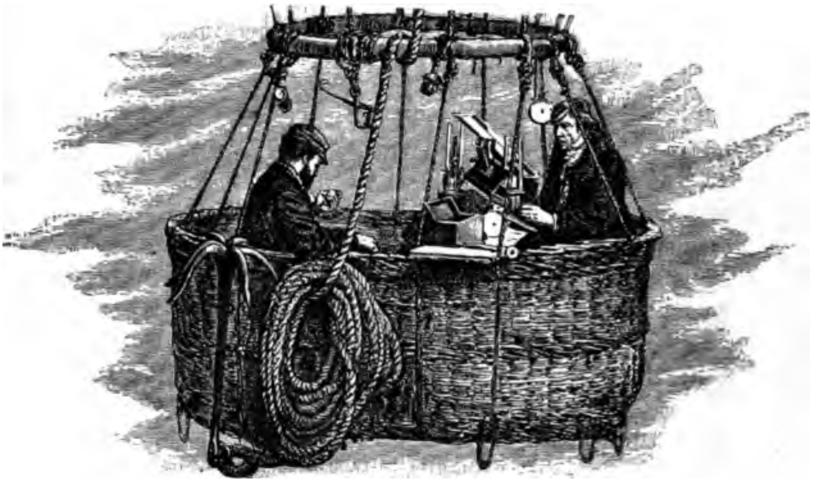

FIG. 1.—Glaisher and Coxwell in Balloon Car, with Instruments.

Though no great improvement has been introduced in the ordinary balloon which floats with the wind, yet great strides have recently been made in the way of providing it with engines and propellers, so that it may be driven to any predetermined goal. Twenty-five years ago the French Government made the first dirigible air-ship, and now they possess one at least that seems to be a really practical vessel of war. *La Patrie* has maintained, during several hours, a speed of 28 miles an hour (which is faster than most steamers go), and is therefore able to stem any light breeze. Count Zeppelin, in Germany, has also produced a machine which in point of size as well as in speed has beaten all records. It is 420 ft. long, and has proved capable of going 30 miles an hour.

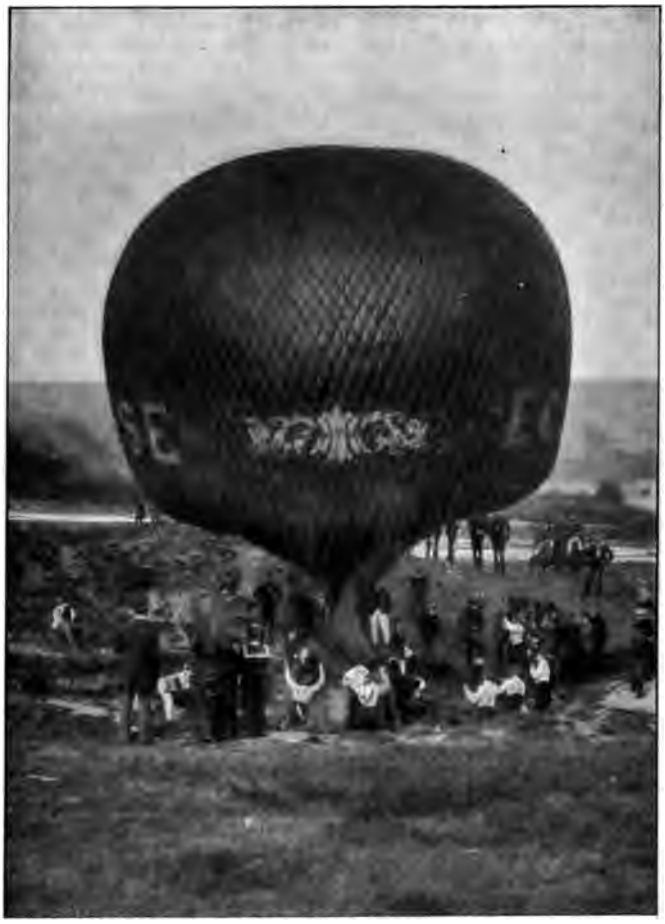

FIG. 2.—Balloon *Eclipse* during Inflation.

Going to the other extreme, we have small balloons now capable of attaining the greatest heights, carrying self-recording instruments. It almost passes our comprehension to think how high these toy-like contrivances can ascend. One has recently ascended to the enormous altitude of 82,000 ft., or nearly 16 miles above the surface of the earth. Although Glaisher's ascent out-topped the highest mountains and placed him among the highest known clouds, this little toy balloon rose to *double* that height!

The International Commission for Scientific Aeronautics, formed a few years ago, arranges for the simultaneous ascents in all countries on certain prearranged days, so that comparisons may be made of the whole strata of the air. The most usually adopted system is that of Herr Assmann, which consists of two small india-rubber balloons connected together by a long string; the meteorograph is fastened near one end of the string. Then, on attaining a great height, the upper balloon will eventually burst, while the lower will prevent too rapid a descent, and will facilitate the finding of the instruments. Mr. E. S. Bruce suggested a small parachute instead of the second balloon.

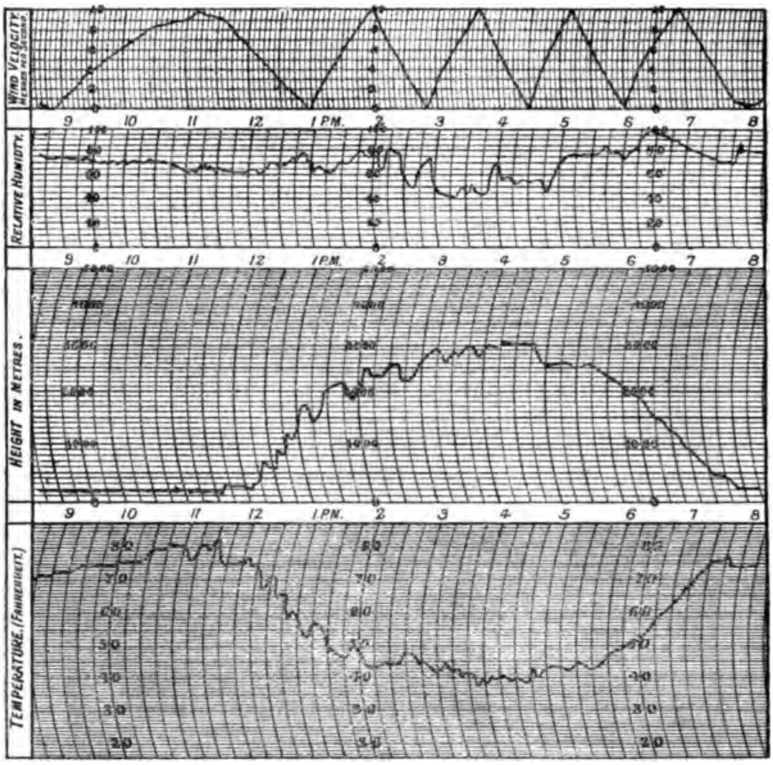

FIG. 3.—Kite Meteorogram, Blue Hill Observatory, August 26, 1898.

The meteorographs, of which we have some specimens here, and which record the atmospheric pressure, the temperature, and sometimes the humidity, are now made in great perfection. Mr. Dines has lately introduced one of great simplicity. Some records are shown here, with the lines formed by the pens on paper fixed around a revolving drum (Fig. 3).

KITES.

Closely connected with this subject of "ballons-sondes," as the French call them, is that of meteorological kites. These also have been much improved in recent years; and instruments lifted by kites, retained by steel wires, have actually ascended to a height of 4 miles. Many varieties in the shape of the kite have been tried, and there does not seem to be any great difference in their efficiency. Here is a picture of an ascent of kites from a steamer. This shows the diamond-shaped box kites used by Mr. Dines (Fig. 4).

I may here mention another use for the kite. If a camera be suspended from one, and the shutter actuated by slow-match or otherwise, a very interesting photograph may be obtained of the country below.

Kites of much larger dimensions have also come into use during the last few years. They are now practically used for lifting men. At Aldershot they have been regularly introduced into the service for war purposes. Men were first lifted by this means in 1895, in which year I made a number of ascents up to 100 ft. high. A later design of my apparatus is shown in Fig. 5. Two main lines are used, fixed apart, and the basket car is suspended between them. But improvements have gradually followed, until now men have actually gone up to a height of 3000 ft., an elevation practically beyond the reach of rifle bullets, and so high as to render the aeronaut almost invisible.

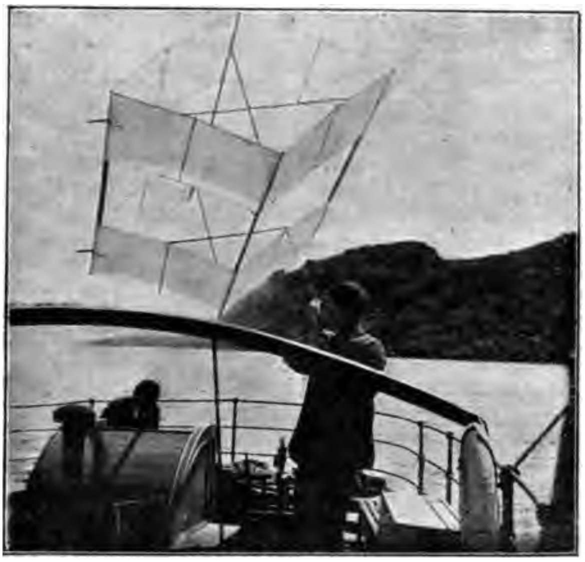

FIG. 4.—Mr. Dines starting a Kite.

FLYING MACHINES.

We now come to a subject which, if it has not hitherto had any very practical results, yet promises to bring about perhaps a more extraordinary change in the life of man than has resulted from any other of the marvellous inventions of the nineteenth or twentieth centuries. The flying machine has come, and it has come to stay.

Years ago people argued that it was impossible to lift in the air that which was far heavier than the air. But the advocates of the cause pointed to the birds, and there was no gainsaying that the thing was possible. Then the pessimists cried that it would not be possible to balance the apparatus without the intelligence of a bird, but models were made (by Penaud, Hargrave, Langley, and others) finally so good as to fly for three-quarters of a mile. Then men took to gliding on wings and sailing on the wind. Lilienthal made thousands of glides. He was followed by Pilcher in England, and by Chanute in America. Huge machines were constructed with very light engines (Fig. 6 is a view of Maxim's great machine); and at last, during the past two or three years, not only have men been successfully raised off the ground, but they have been able to sustain themselves in the air for half an hour

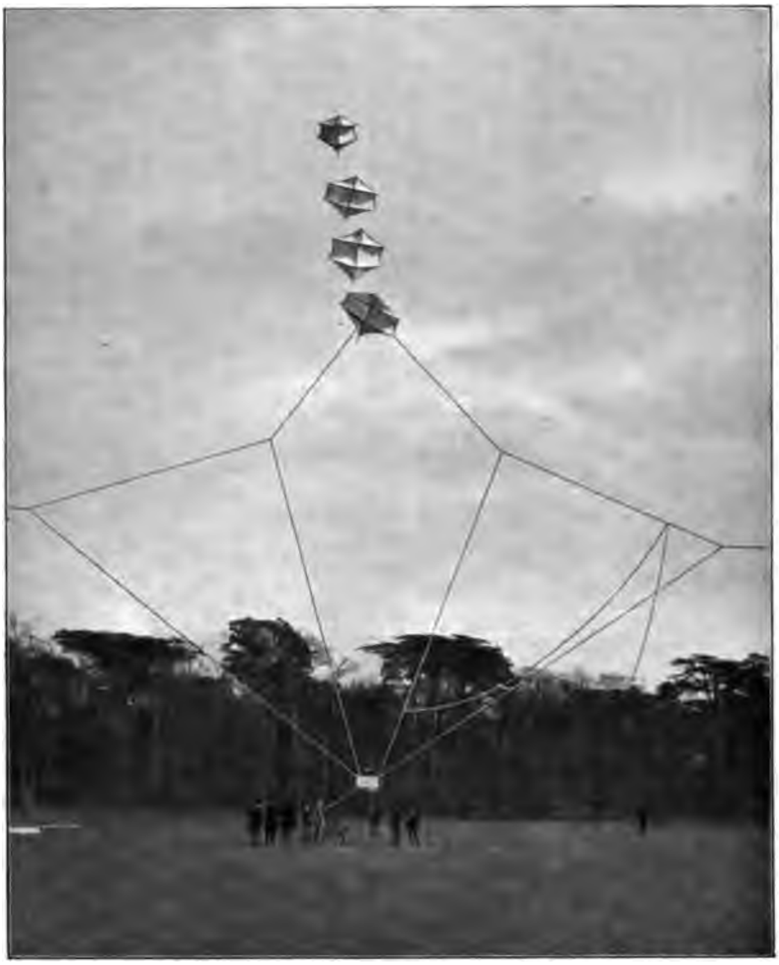

FIG. 5.—Baden-Powell's Man-Lifting Kites.

at a time. The brothers Wright in America are said to have accomplished this feat, while no less than four different forms of apparatus have risen by their own inherent power within the last few months in the neighbourhood of Paris.

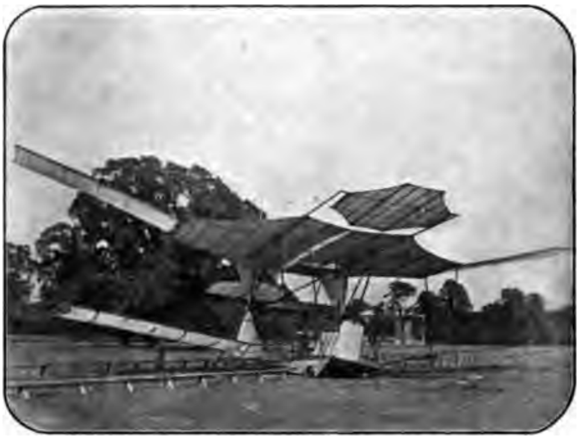

FIG. 6.—Maxim's Gliding Machine.

Very little more remains now to be done before we can say that man has veritably conquered the air, and is able to visit at will those unexplored realms of which we have spoken.

Rain-Making Experiments in the Klondike.

Owing to the scarcity of water for hydraulic mining in the Klondike district, the Government of Yukon Territory and a number of the largest mine-owners and operators made, as reported some time ago in *The Times*, a contract with Mr. C. M. Hatfield, of Los Angeles, who had made many "rain-making" experiments in the arid parts of California. If he produced "a sufficient rainfall to ensure, as far as an ample rainfall would, a successful and prosperous summer, in the placer mining industry," the fact to be determined by a board representing the various parties to the contract, he was to receive $5000 from the Government and $5000 from the miners ; otherwise he was to receive the travelling and living expenses of himself and his assistant. The Commissioner administering the territory now reports that Mr. Hatfield "commenced his demonstrations on June 11, on a high eminence called the 'Dome,' about thirty miles from Dawson. On Hunker, Sulphur, Gold Run, and Dominion creeks the rainfall for June was above the average, but on Bonanza and Eldorado it was below normal. During the early part of July there was no increase over the average of former years. Accordingly, at a meeting of the aforesaid board, held at Dawson on July 23, it was decided that 'in the opinion of this committee the contract entered into on July 10, 1905, has not been carried out, and that Mr. Hatfield be notified that his contract is terminated.' A copy of this decision was immediately sent to Mr. Hatfield, who thereupon desisted from further experiments. The Government of the Yukon Territory paid $1153.05 to Mr. Hatfield in full settlement of its liability under said contract." The Commissioner also reports that agriculture is developing in the territory, and regulations have been made under which homestead land can be acquired on liberal conditions by *bona fide* settlers. Last summer enough ground was brought under cultivation in the Dawson district practically to supply the local demand for vegetables, and the Commissioner expects a large increase in the cultivated area this year.—*The Times*, February 11, 1907.

Rainfall of German South-West Africa.

Dr. Emil Ottweiler has prepared a valuable paper on the rainfall of German South-West Africa, which has been published in the *Mitteilungen aus den deutschen Schutzgebeiten*, Band 20, Heft 1, 1907. He has collected the rainfall records from 96 stations, the observations extending over various periods from 23 years to 1 year. He has, however, in the majority of cases reduced them to "normal" means, and from these he has prepared a large coloured map showing the distribution of the average annual rainfall.

The average rainfall at a number of the stations is given as follows:—

Inland Stations.	Height above Sea-level.	Rainfall.	Stations on the West Coast.	Height above Sea-level.	Rainfall.
	ft.	ins.		ft.	ins.
Onüpa	...	21·46	Zesfontein	...	2·73
Ondangua	...	23·71	Franzfontein	3625	8·91
Olukonda	3510	22·91	Okombahe	3100	5·36
Grootfontein	5020	24·37	Karibib	...	6·01
Outjo	...	17·37	Wilhelmstal	...	14·94
Omaruro	3800	10·85	Kubas	...	4·33
Okahandja	3100	14·86	Otjimbingue	3084	5·38
Gobabis	4650	18·53	Jakalswater	...	1·20
Neudamm	...	15·02	Swakopmund	23	1·16
Seeis	...	13·28	Haris	6300	11·24
Windhuk	5350	14·07	Nauchas	5400	8·81
Oas	4500	18·69	Berseba	3490	3·11
Hohewarte	...	14·43	Bethanien	3068	4·52
Hatsamas	...	14·06	Keetmanshoop	3373	5·85
Rehoboth	4790	10·45	Kubub	4690	2·86
Aminuis	...	12·10	Lüderitzbucht	13	0·54
Hoachanas	4134	9·36	Sandverhaar	...	2·56
Nomtsas	...	8·20			
Maltahöhe	...	6·29			
Gibeon	3700	6·82			

Effects of Wind upon Railways.

The Times of February 21, 1907, says:—"The London and North-Western Railway Company experienced the greatest difficulty in the gale of yesterday in maintaining its train service on the North Wales Coast. The Irish boat express from Euston to Holyhead, drawn by two engines, reached Prestatyn, where the pick-up water troughs are laid, some half-an-hour late. Both drivers expected to obtain the necessary supplies here while running, but found the troughs quite empty. The gale was blowing the water out of the troughs as fast as it ran in, and the train, which is not timed to stop between Chester and Holyhead, had to draw up at Rhyl, where a quarter of an hour was spent in filling both tenders. The 2.55 train westward from Chester had a still more astonishing experience. It reached Abergele very late, and here the wind was so strong that it brought the train to an absolute stand-still. Between the blasts it made a little progress, but even then its speed was reduced to four miles an hour."

PHENOMENAL RAINFALL IN SUVA, FIJI, AUGUST 8, 1906.

By R. L. HOLMES, F.R.Met.Soc.

[Read April 17, 1907.]

It is a duty, as well as a pleasure, to lay before the Society particulars of a very remarkable fall of rain in an electric storm which occurred in Suva, the capital of Fiji, on the night of August 8, 1906. Unfortunately the exact amount has to be, in part, estimated, owing to the absence of continued observations during the night.

Early in September I visited Suva and collected all available information about it from every source.

I first called on Mr. C. H. Knowles, Superintendent of Agriculture, and since January the Meteorological Observer, when he took over the instruments from Mr. G. Gardiner, Government Storekeeper. But I could get no information from him further than that in 24 hours, ending 9 a.m. on August 9, 26½ ins. of rain had fallen. This was repeated later on in the Government *Gazette* monthly report, where it stated in a footnote—"Estimated fall, gauge overflowed." "In a heavy thunderstorm started 6 p.m. on the 8th, continued to 7 a.m. on the 9th." From the tables in the *Royal Gazette*, a very complete and carefully drawn-out list, I gather that the total rainfall for the month of August was set down at 37·33 ins. The mean annual rainfall in Suva in 21 years previous was 102·48 ins. The total rainfall in 1905 was 73·03 ins. The barometer mean, corrected, was on the 7th, 29·978 ins.; on the 8th, 29·937 ins.; on the 9th, 30·007 ins. Miles of wind in 24 hours ending 9 a.m. on the 9th were 96, or average 4 miles an hour. Suva lies in latitude 18° 8′ south, longitude 178° 26′ east.

The only other rain-gauge in or near Suva was one in the hands of Mr. G. Gardiner, Government storekeeper, and formerly meteorological observer, till the instruments, all but the rain-gauge, had been transferred as stated, to the care of Mr. Knowles, and to him I applied with much more satisfactory results. Mr. Gardiner's office lies close to the harbour wharf. It is surrounded by buildings, making it necessary to place the rain-gauge on the roof, 25 feet above ground, whence it is connected by a small pipe with a lock-up cupboard in the office.

All parties agree that very little rain fell before sunset, near 6 o'clock on the 8th, and that it continued a ceaseless downpour till sunrise on the 9th. If anything the rain increased in volume in the middle of the night. At 3 p.m. on the 8th, or 3 hours before the downpour began, Mr. Victor Moore, Mr. Gardiner's assistant, emptied the gauge, and, what has saved the situation, returned at 10 p.m. and found the gauge overflowing with 12·50 ins. of rain in it: say 12 ins. since 6 o'clock. Four hours later, at 2 a.m. on 9th, the gauge was certainly again overflowing; and at 6 a.m. once more, though it was not emptied till later, about 9 a.m.; three times in 12 hours, or let us say 13. Very little rain fell after 6 a.m.

The overflowings should be taken into account and added to the rest, but I omit them altogether, as I can make no estimate. I reckon only 37 inches from three fillings of the gauge, which is certain. Furthermore, I pointed out to Mr. Gardiner that his rain-gauge, placed 25 ft. above the ground, did not show the proper amount of precipitation by a long way. Scientists have gone very carefully into this question, which I need not now repeat. (See Buchan's *Handy Book on Meteorology*, p. 189, etc.) The fall, 25 feet above ground, should be increased by about 11 per cent compared to what is collected in a gauge near the ground: so that 37 ins. would read 41 ins.

I have to thank Mr. Gardiner for all the valuable information which he gave me, and which alone has enabled me to write this report.

The effects of the flood in and near the town were, of course, considerable; but owing to Suva lying on a peninsula, with only low hills about, and the watershed to eastward only one mile distant, the damage was mostly confined to streets and cellars, and ground floors of the buildings—tearing up the streets and bursting up culverts and small bridges. The Hon. H. Marks was a heavy sufferer, a reclamation wall recently built on Nabukalow creek, at a cost of £400, being destroyed.

The two Suva papers, the *Fiji Times* and the *Western Pacific Herald*, give long accounts of the whole affair. The former paper says:—

> It was a few minutes before 6 o'clock, and almost dark, when Jupiter Pluvius began operations, and without intermission they continued until near 7 o'clock on Thursday morning. Such rain too! Throughout the night the torrents seemed constantly to increase in force and volume; and after nightfall lightning remarkably vivid and diverse was incessant, accompanied with much thunder, some peals sounding quite close to the earth. The wind was strong and gusty, and shifted all round the compass. In less time than it takes to tell all the water channels were foaming cataracts, and the lower parts of the town were soon knee-deep in water. The ordinary drainage was futile in such a deluge. At 6 a.m. on Thursday the force of the storm was exhausted, and intermittent light showers fell during the day, with some heavier ones after dark.

Mr. Alport Barker, proprietor of the *Western Pacific Herald*, gave also in his paper of August 10 a full account of the whole affair. It states—

> Slight showers of rain fell during the afternoon, but towards sundown, heavy banks of cloud foretold a heavier rainfall. An hour later it was raining heavily with a strong wind blowing. Towards 7 o'clock flashes of lightning were observed, followed by loud peals of thunder, and so it continued through the night, incessant lightning flashes, crashes of thunder, and a steady deluge of rain, the latter being the cause of much mischief. In Gordon Street the main drain to the beach was choked, and the water overflowed into the back premises of the *Western Pacific Herald* office, and through the front offices, and in some instances was to a depth of 20 inches. A considerable amount of printing material and other goods were destroyed, and when the water subsided it left a coating of mud about 2 inches deep.

H.M.S. *Pegasus* was in Suva harbour at the time, and several persons told me the officers on board had measured the rainfall, so I wrote to Commander Doyly on his return from New Hebrides, September 18, asking particulars, but got no reply. Doubtless I was misinformed.

Rain-gauges, within say 20 miles of Suva, gave returns for the 24 hours of 9 to 12 inches. At Mausori, on the Rewan, 12 inches; at Bau, 8 inches.

I have carefully examined my many works on Meteorology to find noteworthy precedents, namely:—Sir John Herschel, L. F. Kæmtz, A. T. Morris, Admiral FitzRoy, Alex. Buchan, Captain Maury's *Physical*

Geography of the Sea and its Meteorology, and others; and some extracts I cut out from a copy of *Nature* some years ago, giving a summary of abnormal rainfalls, collected from all sources. From all these I quote the most remarkable. At Nedunteni, in Northern India, the rainfall in December (year ?) during 24 hours was 31·76 ins. At Joyeuse, in France, 31·17 ins. in 22 hours; at Geneva, 30 ins. in 26 hours; Gibraltar, 33 ins. in 26 hours; Bombay, 24 ins. in one night. These are eclipsed by the record from Khasia Hills, North-east Bengal, of 30 ins. on each of 5 successive days. The average annual record of this the wettest place on earth, being 600 ins., of which 500 ins. fall in 7 months. In Queensland, Australia, there fell 37·71 ins. in 24 hours, in 1893, at Crohamhurst, Upper Brisbane river, during the great flood. Near Cape Horn, Captains King and FitzRoy's gauge showed a fall of 153·75 ins. in 41 days (see Maury, p. 442). Here, on the north coast of Vanua Levu, Fiji, to compare small things with great, I have registered 14·95 ins. in 24 hours, during a hurricane on March 10, 1871, and in 7 days, 29·43 ins. In March and April 1893, 40·56 ins. in 7 days, and 44·06 ins. in 10 days.

On the night of August 8, 1906, during the great rainfall in Suva, we had here, over 100 miles away, a clear starlight night, quite calm. But our attention was forcibly directed to incessant sheet lightning flashes down south, and over Suva, as we afterwards learned. No thunder was heard, but a very peculiar ceaseless flashing of sheet lightning, also, to the north over the sea, like the reflection of what occurred south,—a complete mystery to us.

I have said enough, perhaps more than enough, on this deluge, etc., but I hope the Fellows of this Society will consider it carefully, and say whether Suva beats the world's record for rainfall in 13 or 14 hours? It seems to me that it certainly does.

DISCUSSION.

Mr. F. **Campbell Bayard** said there were one or two points in the paper to which he would like to call attention. Mr. Holmes said that the gauge overflowed, but he (Mr. Bayard) did not quite know what this meant. It might mean that Mr. Holmes had some fixed vessel down below, into which the water flowed, and from which he took his readings. Mr. Holmes also said that a fall of 25 ft. above the ground should be increased by 11 per cent, compared with what was collected in a gauge near the ground, so that 37 ins. should read 41 ins. This was a question with which the President would be most competent to deal. The late Mr. Symons went very closely into this subject, and the percentage he gave was about 8 per cent. The point which he chiefly wished to emphasise was that they did not know what Mr. Holmes exactly meant when he said the gauge overflowed, and he thought some steps should be taken to gain information on this point.

Capt. M. W. C. **Hepworth** agreed with Mr. Bayard that it was a pity Mr. Holmes had not told them more about the rain-gauge; and he (Capt. Hepworth) would like to know something as to the construction of the roof; he thought it possible that some of the water from the roof might have got into the rain-gauge. Suva is situated on the south side of the island of Viti Levu, but at the eastern end. The heaviest rainfall is found to be on the south-east coast. He did not think the rainfall at Suva was a record. At Cherrapunji, on June 14, 1876, they had 40·8 ins., and two days previous to that 30·45 ins. There seemed no doubt that the rainfall was very heavy, but he was not sure that the measurements were to be exactly relied upon.

Mr. **Richard Bentley** said that the present paper once more illustrated the necessity for the larger and adequate recording capacity of rain-gauges, and more especially in tropical countries. Moreover, all gauges should be "jacketed" ones, *i.e.* placed within a second container (which might be of a very inexpensive material or make) capable of receiving and preserving an overflow, if very exceptional rains or cloud-bursts occurred, for subsequent measurement. Such duplex containers were also a security under ordinary conditions in case of the inner holder springing a leak if worn and put back roughly, or on being strained by ice, etc.

Mr. W. W. **Bryant** said the amount of water collected in gauges varied greatly under different conditions. They found at the Royal Observatory, Greenwich, that a rainfall on the roof showed a deficiency compared with a rainfall near the ground, varying from 100 per cent to nothing or even less, according to the rate of fall and other conditions. It was difficult to conceive whence the 4 ins. suggested in the paper could be derived during the last 25 ft. of fall.

Mr. W. **Marriott** remarked that he would have liked before speaking to have Dr. Mill's opinion on the paper, as he was an authority on the subject of rainfall. Mr. Holmes's paper was extremely interesting. They would like to have known something of the atmospheric conditions prevailing at the time; they simply knew that there was a thunderstorm. If an isobaric chart had been prepared they would probably have had some information as to the conditions under which the rain fell. The question of the exposure of the rain-gauge was an important one. The rain-gauge was evidently of an old pattern, in which the funnel on the roof was connected with a long pipe which came down to a room below, where the rain was received in a can or cylinder. It was evident that the can overflowed in the evening, and that it was emptied and put in again, and that about 2 a.m. it was found to be overflowing again, when presumably it was again emptied. At 9 o'clock the next morning it was found that the can was again overflowing. This made three times 12½ ins. plus the overflows. The question of the percentage to be added for the rain-gauge being 25 ft. above the ground, would depend upon the character of the wind at the time. If the wind was strong, the gauge would collect less, but in calm air there would probably be but little difference; and so 11 per cent would be a great deal too much to add. They had, however, definite information that 37 ins. was measured, which was certainly a very large amount. Captain Hepworth had referred to the rainfall at Cherrapunji, but had only mentioned two instances of falls over 30 ins. There was, however, another instance, viz. 32·24 ins. on September 29, 1877; and five consecutive days in June 1876 produced 115 ins., or nearly 23 ins. per day. At Cherrapunji, in July 1865, there were 9 consecutive days with falls ranging from 10 to 17 ins., or an average per day of 14¼ ins. Mr. Marriott quoted several instances of very heavy rainfalls in various parts of the world. At Tanabe, in Japan, there had been 35·4 ins. in one day, and 50 ins. in 40 hours; and at Purneah, in North Bengal, 35 ins. fell in one day. The greatest amount of rain in one day in Great Britain was 9½ ins. at Scarborough on August 6, 1857. The gauge, however, overflowed, so the rainfall might have been more than 9½ ins. A very important question was the kind of rain-gauge, and also its capacity. In mountainous districts, where there was likely to be very heavy rain, the can or cylinder inside the gauge should be of sufficient capacity to hold the greatest amount likely to fall. Mr. Symons had recommended that all gauges should hold, at least, 5 ins., because there was no knowing when there might be a rainfall of 5 ins. At Angerton, in Northumberland, 6·70 ins. fell on September 7, 1898. It behoved all observers to see that their rain-gauges were of sufficient capacity, that they did not leak, and that they were properly exposed; and also that they conformed to the rule of the funnel being one foot above the ground, and not at different heights.

THE PRESIDENT (Dr. H. R. MILL) said that there were one or two points in the paper of exceptional interest. They would like to know something of the exact pattern of the rain-gauge, and the nature of the receptacle in which the rain was collected. The first rain-gauge known to have been used in this country, at Townley, in Lancashire, in the year 1677, was similar in character to that which seems to have been used in Fiji. The funnel was placed on the roof, and the water collected in a glass tube, graduated to tenths of an inch. There was a somewhat similar one at the Radcliffe Observatory at Oxford. There was nothing inherently bad in this method; and if all the conditions were known, it might be possible to obtain correct values. As Mr. Bryant had observed, the amount of water collected in high and low gauges varied extremely under different circumstances. One could only correct for height by taking the average for a year, or for some long period, and this practically involved assuming an average wind. In very heavy rain there was less difference in the catch of high and low gauges than in light rain; and in heavy rain in still weather actually more rain had sometimes been caught at a great elevation than on the ground. The total amount of wind in the 24 hours during which the remarkable fall occurred was 96 miles, averaging only 4 miles an hour. This was very little, and one would expect that the amount of rain falling at 25 ft. above the ground would be very nearly the same as at 1 ft., so that the 11 per cent addition was probably unnecessary, or at least it was too great. Something should of course be added for the three overflowings, and they might accept the fact that more than 37 ins. of rain fell in the 13 hours. The small range of pressure seemed curious. There were, however, only two readings of the barometer cited in 12 hours. A great depression of the barometer was to be expected with so much precipitation, and possibly such a depression occurred and passed between the two readings. The long duration of the heavy rain was not a usual feature. It would have been interesting had a barograph trace been available; possibly one might have been obtained from H.M.S. *Pegasus*. Another remarkable feature was the extremely slight amount of damage done. Three inches of rain in this country falling in one hour would cause much damage, but here 3 ins. fell every hour for over 13 hours consecutively, which left one wondering at the stability of the Fijian houses. Thirty-seven inches plunging down on the surface of the island must have given rise to a tremendous sweep of water over the land. In America, where heavy floods were comparatively common, towns had been swept away by much smaller quantities. When he (Dr. Mill) was in Arizona two years previously, a flood, caused by a fall of about 2 ins. of rain, had swept away a railway station a few hours after he had passed through. With regard to Cherrapunji, the annual average now accepted was, he believed, 500 ins. and not 600 ins. as was formerly thought. The President thought they should convey the thanks of the Society to Mr. Holmes for sending a paper which had evoked so much discussion.

Rainfall at Delanasau, Bua, Fiji, 1906.

Delanasau is in lat. 16° 38′ S., long. 178° 37′ E., and is 1 mile distant from the sea. The height of the rain-gauge is 71 feet above sea-level.

1906.	Rainfall. Ins.	Days of Rain.	1906.	Rainfall. Ins.	Days of Rain.
January	11·19	16	August	5·10	9
February	3·04	8	September	1·53	6
March	11·50	19	October	8·78	10
April	11·35	19	November	4·85	13
May	2·76	6	December	17·04	18
June	1·65	5			
July	2·00	6	Total	80·79	135

The total rainfall was 29·93 ins. more than fell in 1905; nevertheless it alters the mean of previous years very little. Thus the 11 years' mean to December 31, 1906, was 74·34 ins. The previous 25 years' mean was 99·71 ins. The mean for 36 years, 92·20 ins., and the mean number of rainy days for 36 years was 156.

On February 13, 1906, the maximum temperature in the shade was 99°·3. I have not heard of this heat in the shade having been exceeded at any time or place in Fiji.

A great storm occurred here on the night of November 30. It was a straight gale blowing steadily throughout from South-east. The following are the readings of the mercurial barometer with all corrections and the temperature:—

			Barometer. Ins.	Temperature. °
Nov.	30	11 p.m.	29·678	77
,,	,,	Midn't.	29·616	77
Dec.	1	1 a.m.	29·440	77
,,	,,	2 a.m.	29·500	77
Dec.	1	3 a.m.	29·614	76
,,	,,	6 a.m.	29·699	76
,,	,,	9 a.m.	29·844	78

Between 12 and 1 we made sure we were in for a great hurricane; every thing pointed to it:—a rapidly falling glass with wind steady from South-east, which meant that the centre of the storm would pass over here. There was no thunder, but heavy rain; the amount for the 24 hours being 3·58 ins. The wind increased in force rapidly, and we continued preparations to meet it. But presently after 1 a.m. the barometer began to rise and the storm to abate. The damage done was considerable, but nothing serious. It appears to have done more harm in Lau, the Windward Islands, and in Taviuni.

This storm reminded me of the hurricane of January 20-21, 1904, about which there was so much disagreement. It was the result of a great storm from South-east meeting one from North-west in the centre of the group, with the usual result, a revolving hurricane that did so much damage in Levuka and elsewhere, and then passed away to the South or South-east.

A correspondent in Levuka wrote me:—"It originated close to Angau, 35 miles south-east of Levuka." This half did originate to the southward, and the northern half, as we living on north-west Vanua Levu know only too well, came from the North-west of the monsoon, and blew continuously for 10 days, increasing to a great gale on January 20 and 21. The two storms met south of Bouwalu, and formed a revolving hurricane.

Mr. G. C. Barratt, of Wainunu, has sent me particulars of the rainfall there in 1906. Wainunu lies on the south side of this large island, Vanua Levu, about 20 miles from here; homestead, 4 miles inland; 20 ft. above sea-level. The total rainfall in 1906 was 142·55 ins., compared to 149·87 ins. mean fall in 27 years, including 1906. The maximum fall was 232·70 ins. in 1894; and the minimum fall 100·21 ins. in 1884.

	Ins.
January	8·42
February	3·18
March	16·47
April	27·53
May	13·67
June	3·66
July	5·63
August	12·31
September	6·94
October	5·92
November	16·56
December	22·26
Total	142·55

This shows in a forcible manner the excess of rainfall on the south sides of the island compared to the northerly parts; the South-east Trades, moisture-laden from the boundless ocean, striking the high lands, and then passing across to our side comparatively dry.

Mr. Barratt adds: "We had 9·50 ins. on night of November 30, a great storm, but, as you say, wind in one direction only. The highest flood we have had for years. . . . We had some very hot days, 98° in the shade, and very cold nights, down to 58°."

R. L. Holmes, F.R.Met.Soc.

TEMPERATURE AROUND THE BRITISH ISLANDS IN RELATION TO THE GULF STREAM.

By RICHARD STRACHAN, F.R.Met.Soc.

[Read April 17, 1907.]

This is a study based on observations made in the year 1906, which have been published by the Meteorological Office. The data used are for positions at or about the north of Scotland, lat. 59° N., long. 5° W.; south-west of England, lat. 49° N., long. 5° W.; west of Ireland, lat. 54° N., long. 10° W.; east of England, lat 54° N., long. 0°; Irish Sea, lat. 54° N., long. 5° W.; Strait of Florida, lat. 25° N., long. 81° W.; on Equator, long. 30°; and they are indicated respectively by the letters N., S., W., E., C., F., Eq., in the accompanying Tables:—

TABLE I.

1906.	Air Temperature.					Sea Temperature.						
	N.	S.	W.	E.	C.	N.	S.	W.	E.	C.	F.	Eq. 30°.
	°	°	°	°	°	°	°	°	°	°	°	°
January . .	40	47	44·6	41	43	44	50	44	44	42	75	80
February . .	37	44	41	38	39	42	49	47	41	44	75	81·5
March . .	37	46	43	41	42	44·5	47	48	42	43	73	81
April . .	41·3	48·2	45·4	44·2	44·4	45	48	46	43	45	76	82
May . .	43·5	50·6	40·7	50	48·1	47	51	51	45	48	78·5	81·5
June . .	50·3	58·3	55·4	55·9	55·9	51	58	56	52	53	81	80
July . . .	51·3	61·4	57	58·5	55·8	51	59	59	57	57	85	79
August . .	52·8	63·5	59·1	62·7	58·9	55	62	61	56	59	84	78
September .	52·1	60·9	57·1	58	54·4	56	60	58	54	59	85	77
October . .	47·5	55·6	51·3	52·6	51·3	53	58	54	52	55	82	80
November .	44·7	53·5	47·0	45	47·2	51	54	52	49	50	79	79
December .	38·5	45·8	43·4	36·7	40·4	49	51	49	44	47	76	79
Year . .	44·7	52·9	49·5	48·6	48·4	49·0	53·9	52·1	48·2	50·2	79·1	79·8

TABLE II.

1906.	Sea warmer than Air.					Florida Strait warmer than Sea at					
	N.	S.	W.	E.	C.	N.	S.	W.	E.	C.	Eq. 30°.
	°	°	°	°	°	°	°	°	°	°	°
January . .	4·0	3·0	−0·6	3·0	−1·0	31	25	31	31	33	−5
February . .	5·0	5·0	6·0	3·0	5·0	33	26	28	34	31	−6·5
March . .	7·5	1·0	5·0	1·0	1·0	28·5	26	25	31	30	−8
April . .	3·7	−0·2	0·6	−1·2	0·6	31	28	30	33	31	−6
May . .	3·5	0·4	1·3	−5·0	−0·1	31·5	27·5	27·5	33·5	30·5	−3
June . .	0·7	−0·3	0·6	−3·9	−2·9	30	23	25	29	28	1
July . . .	−0·3	−2·4	2·0	−1·5	1·2	34	26	26	28	28	6
August . .	2·2	−1·5	1·9	−6·7	0·1	29	22	23	28	25	6
September .	3·9	−0·9	0·9	−4·0	4·6	29	25	27	31	26	8
October . .	5·5	2·4	2·7	−0·6	3·7	29	24	28	30	27	2
November .	6·3	0·5	5·0	4·0	2·8	28	25	27	30	29	0
December .	10·5	5·2	5·6	7·3	6·6	27	25	27	32	29	−3
Year . .	4·4	1·0	2·6	−0·4	1·8	30·1	25·2	27·0	30·9	28·9	−0·7

The temperatures of the air have been obtained from the ***Monthly Weather Reports***; those of the sea from the ***Monthly Meteorological Charts for the North Atlantic.***

At the north of Scotland the sea was warmer than the air, as much as 10°·5 in December; the only exception was July, but merely 0°·3 colder.

In the chops of the Channel the surface water was as warm as, or colder than, the air from April to September (inclusive), 2°·4 in July; and in other months warmer, 5°·2 in December.

Off the west of Ireland the sea surface was 0°·6 colder than the air in January; during the rest of the year warmer, most so in December, 5°·6.

Off the east of England the sea was colder than the air from April to October (inclusive), much colder than the west of Ireland; in December, warmer than the air, 7°·3.

The temperature in the Irish Sea varied from 2°·9 colder in June to 6°·6 warmer in December than the air.

The ranges of these variations during the year were 10°·8, 7°·6, 6°·6, 14°·0, 9°·5, the mean being 9°·7.

The temperature of the air was lowest in February, highest in August; that of the sea corresponded to these epochs with slight interruptions, having been lowest in January for the west and central, in March for the south, highest in September for the north, and in July for the east, positions.

The Florida stream was warmer than the north of Scotland, in July 34°, in December 27°; than the Land's End, in April 28°, in August 22°; than West Ireland, in January 31°, in August 23°; than the North Sea, in February 34°, in July 28°; than the Irish Sea, in January 33°, in August 25°. The ranges of these temperature-differences are respectively 7°, 6°, 8°, 6°, 8°, averaging 7°.

The decrease of sea temperature per one degree of latitude between the Strait of Florida and the north of Scotland was 0°·9; to the English Channel, 1°·0; to west of Ireland, 0°·9; to east of England, 1°·1; to Irish Sea, 1°·0. The near equality of these results is to be remarked.

In the *Phil. Trans.*, vol. lxxi. p. 334, there is a memoir by Charles Blagden on the "Heat of the Water in the Gulf Stream," in which he deduced the decrease of temperature from Cape Florida to the Land's End to be 2° for three degrees of latitude, that is 0°·67 per degree.

The temperatures of the air being from systematic observations, whilst those for the sea may be from many or few, the concordance of the results may be deemed satisfactory, so that inferences may fairly be drawn from them.

The Land's End benefits more from the Atlantic drift than the west of Ireland, or the Irish Sea, still more than North Scotland, and the North Sea least.

This drift is regarded as the spreading out of the deep current called "Gulf Stream," under the influence of predominant Westerly winds.

The monthly temperatures indicate that in the Strait of Florida the water has its maximum and minimum at or about the same time the British seas have their highest and lowest. Thus the cosmical causes productive of their temperatures appear to act simultaneously.

The Gulf Stream, according to Humboldt's estimate, requires two to three years to accomplish its course. Such a period has been greatly reduced by additional observations. Rennell gave it 270 days. It can only be derived from averages, rough at best, of all available observations; those for particular months, or aggregates for the same nominal month, are far too scanty. The *Currents of the North Atlantic*, published by the Meteorological Office in 1870, show the Gulf Stream only as far as lat. 40° N. According to the general chart the average time taken in this course is 27 days. The currents shown on the *Monthly Meteorological Charts* allow the following additional estimates to be made: in lat. 43° N., from long. 65° to 40° W., 61 days; from lat. 43° N., long. 40° W., to lat. 50° N., long. 5° W., 144 days; also from lat. 43° N., long. 40° W., to lat. 60° N., long 0°, 267 days. Hence, days from Strait of Florida to Land's End, 232; to north of Scotland, 355. As the sea at the north of Scotland is warmer than the air all the year round, and as 355 days nearly complete a year, it is not too much to conclude that the Gulf Stream takes a year to complete its course from the Strait of Florida to the Arctic Ocean. Hence there can be no surprise that the British seas are coldest about the same time that the temperature of the Strait of Florida is lowest, and that the like coincidence occurs with their maximum temperatures. The march of the respective temperatures is practically the same. There does not appear any reason why a forecast for any one station based upon the latest information from another or others would be of value.

A. G. Findlay's *North Atlantic Memoir*, 1865, p. 259, has a chart for currents on which is shown the Gulf Stream from its source in the Gulf of Mexico to its drift beyond lat. 60° N. in the Arctic Ocean. He estimated 70 days for the current to attain lat. 42° N. long., 40° W., from the Strait of Florida; thence its drift to Land's End, 140 days. The drift from lat. 42° N., long. 40° W., to lat. 50° N., long. 35° W., seems to require 35 days; thence to the north of Scotland, 180 days. Thus, to the north of Scotland, 70 + 35 + 180 = 285 days are required, and to the Land's End, 70 + 140 = 210.

DISCUSSION.

Capt. M. W. C. **Hepworth** said he was glad Mr. Strachan had reintroduced this subject, and had made use of the monthly North Atlantic charts published by the Meteorological Office in doing so. He would like to ask Mr. Strachan from which class of observations he had obtained his sea-surface temperature results; whether they were those of the coast stations, or those derived from ships' observations? The insets, on the charts referred to, showing mean surface temperature gave results of observations made from ships grouped in 2° squares; but round our islands there were two classes of observations of sea temperature: those referred to in 2° squares, and those obtained at coast stations. The two classes of results were not comparable. He thought Mr. Strachan had taken the results for the stations about the north of Scotland and south-west of England from the 2° squares, and the remainder from the coast stations. The temperatures given in the 2° squares would be the more valuable for the purpose required. He thought it would have been better, moreover, had Mr. Strachan compared the departures from the mean sea temperatures for the month with the departures from the mean air temperatures for the month, instead of comparing the mean sea temperatures of a month with those of the air. Mr. Strachan had stated that: "The Land's End benefits more from the Atlantic drift than the west of Ireland, or the Irish Sea still more than North Scotland, and the North Sea least." One year's results were not sufficient data on which to base such a conclusion. Last year was an exceptional year as regards the temperature of the Atlantic; from July to the end of the year, over a large portion of the Atlantic, the surface water was considerably above the average temperature; a good deal of Gulf Stream water penetrated to our shores. In August the English Channel was much warmer than usual, and in September the temperature of the water surrounding our islands was above normal. He had been told by Dr. Allen, the Director of the Marine Biological Association, that in July last a species of pelagic mollusc which abounds in the south-western Atlantic was found in the English Channel: a rare occurrence. In making comparisons between the temperature of the water in Florida Strait and that of localities round our coasts, should not the difference of temperature due to the difference of latitude of the coast station be taken into consideration, and the depth of water at each station also? His own impression was that the waters to the north of Scotland and east of England derive more benefit from the Gulf Stream than the other stations mentioned by Mr. Strachan. If the Gulf Stream did not reach our shores, our islands would still derive warmth from the sea. In estimating the time taken for the Gulf Stream to accomplish its course, it should be remembered that the surface current is often retarded by adverse winds, but below the surface the stream flows on uninterruptedly. It seemed probable to him that where there is a large body of water in motion, like the Gulf Stream, any additional impetus given at its source is soon transmitted to the whole body of the stream.

Dr. H. N. **Dickson** added his support to Captain Hepworth's statement. The change from the actual stream current, which they called the Gulf Stream, into the drift current in the higher latitudes was in his opinion specially important. This change made it very difficult to begin at the far end of the Gulf Stream and connect the facts directly without any intermediate record. They had this drift current coming across from the region of the Newfoundland Banks, and they knew that the supply of Gulf Stream water varied considerably from year to year; then they had a very distinct discharge from the water of the Labrador current, which mixed with the Gulf Stream water. Again, there were large quantities of Polar water which came as surface water down the west coast of the islands, the east coast of Iceland, and the Faröe Islands. They ought to take all these intermediate factors into account.

Mr. D. J. **Matthews** said he had only one point to raise, whether the current moved on the surface the whole way or at times below it. In April 1905 a body of surface water of over 37 per cent salinity broke away from the area where such water is usually found, in 20° to 25° N. lat., and 50° to 60° W. long., and moved in a northerly and easterly direction to 40° N. It could be traced on the surface month by month across the Atlantic until it reached a point off the south-west coast of Ireland about the beginning of August. The plankton and the unusually high salinities found showed that it had reached the entrance to the English Channel about the middle of the month, though now much diluted by admixture with fresher water.

Dr. **Theodore Williams** said he had been very much interested in the Gulf Stream, and listened with great interest to the paper and remarks. The influence of the Gulf Stream is as great as ever. He had heard nothing really of any substantial value in opposition. They could not gainsay the fact that the harbours in Norway were kept open all the winter by the influence of that current. There was no question that the winter warmth of the English Channel, and the places situated on it, was derived from the Gulf Stream. It was certainly correct that the east coast of England was not so warm as the west coast of Ireland. The general fact remained that the Gulf Stream did affect these islands and Norway.

The PRESIDENT remarked that a number of years ago he had made a laborious investigation into the temperature of the sea off the west coast of Scotland. He could not, speaking from memory, be sure of the exact numerical values of the results; but the surface layer of water to the depth of 5 fathoms was, on the average of the year, about 2° higher in temperature than the air, and even in summer, when both night and day temperatures were considered, the surface water of the Atlantic was found to exercise a warming influence on the air.[1]

Mr. R. STRACHAN said, in reply, that it is well known that the Gulf Stream influences the climate of the British Islands, as it is in connection with the Atlantic north-easterly drift. Sir Edward Sabine, having had personal experience of the stream in 1822, appears to have formed the opinion that it might be possible to anticipate unusual seasons here from abnormal velocities in the Strait of Florida. This idea has been often reproduced, and he (Mr. Strachan) had for years been anxious to study the problem, but suitable data were not available until the Meteorological Office entered upon its new career. The officials had effected surprises. Iceland had been embraced by telegraph. A dance of a wind vortex in the chops of the Channel during the whole of the last week had been closely defined; but, more surprising than all, some four or five thousand observations of the surface temperature of the North Atlantic had been collected and published on the monthly charts within six weeks of each month. These observations are just what were wanting. Out of curiosity the tabulation given in the paper was commenced, and every month made it more desirable to complete the year. The probable temperature was taken not merely from a 2° square, but by due consideration of the adjacent squares. Finding the results more consistent than expected, it seemed as well to test them by an estimate of the duration of time a particle of water from the Strait of Florida might take to reach the Arctic Ocean. The estimate was made from the current charts as fairly as possible. The distances apparently traversed by the mean daily rates gave the number of days. Doubtless such estimate might be repeated with somewhat different result, either by the same or different persons. It has here been performed once without any preconceived notions.

The PRESIDENT said they were much indebted to Mr. Strachan for writing this paper, and pleased to have him again amongst them. He wished to convey the thanks of the Society to Mr. Strachan for his kindness in coming there and for the interesting discussion in which he had taken part.

Effects of the March 1907 Sunshine.

The large amount of extra sunshine during March brought on the vegetable crops very favourably in the West of England. "The broccoli traffic from the Penzance district to all parts of the kingdom," says the *Great Western Railway Magazine*, "has been remarkably heavy this season. A record quantity was handled during the week ending April 6, 1081 waggons being despatched from West Cornwall, necessitating the running of thirty-eight special trains."

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[1] See "Temperature of the Clyde Sea Area," *Trans. Roy. Soc. Edinburgh*, **38** (1894), p. 1 *et. seq.*

Mirage in the Desert.

A party of New York mining engineers have just narrowly escaped with their lives in Death Valley, California, famous for the whitened skulls of its victims, which "Scotty," the cowboy millionaire, used to say he passed on the way to his mysterious gold mine.

A week ago the New Yorkers left Los Angeles in automobiles, attracted by news of a fresh strike of gold in Willow Creek. For two days nothing was heard of them, so a rescue-party followed. Eventually they discovered, by means of the telescope, a group of men at the foot of Sheep Train Gorge. The rescuers were just in time, says a *Telegraph* message, for all the engineers were semi-delirious. They had seen what looked like a clear river several thousand feet below, but the mirage enticed them into a waterless gorge, where the heat almost suffocated them.—*Evening Standard.*

Hot Sunshine causes a Railway Accident.

The Report of Lieut.-Col. Druitt, R.E., with reference to his inquiry into the causes of the accident which occurred on March 26 to a passenger train which left the rails near Felling, on the North-Eastern Railway, has been published by the Board of Trade. Eight passengers were seriously injured, two of whom have since died. The accident occurred at 1.45 p.m. on a hot, sunny day, and Colonel Druitt thinks that there can be no doubt that the derailment was caused by a sharp kink being formed in the down line by the expansion of the rails, due to an unusually hot sun for the season of the year, and probably aided by the position of the line in a deep cutting. On March 26 there had been a sharp frost in the early morning, and this was followed by a very still day, with hardly any breeze and a hot sun in a cloudless sky, and, as the lines run east and west, the sun would beat down against the heads and south sides of the rails and cause considerable expansion. The line is in a deep cutting, which kept off the slight breeze, and the south side of the cutting having a very gentle slope, gave no shade to the line. The ballast, being of ashes, would probably give off heat by radiation, and tend to still further increase the temperature of the rails. The nuts on the bolts of the fishplates were all screwed up tight, as is the custom in the winter and cool months, and the platelayers in charge did not slacken these off, nor go along their length of line in the middle of the day on the look-out for tight joints, as is their custom in the hot months of the year. Probably the bulging of the rails took place only very shortly before it was noticed. He considers the derailment was purely accidental, and was due to abnormal temperature and conditions for the time of year, which could not be reasonably expected by the men in charge of this length of line.

The Hong-Kong Typhoon of September 18, 1906.

It will be remembered that a very sudden and most destructive typhoon burst over Hong-Kong on the morning of September 18, 1906. Immense loss of life occurred, and there was great destruction of property and many ships were wrecked.

As the Black Drum announcing the approach of the typhoon was only hoisted just as the storm was bursting on Hong-Kong, there was a strong local feeling that the Observatory authorities ought to have given earlier warning.

The Governor, on September 24, appointed a Committee to inquire whether earlier warning could have been given to shipping. This Committee examined witnesses and received documentary information, which has now been published in their *Report.*

Their conclusion is as follows: "Reviewing the evidence as a whole, the Committee find that prior to 7.44 a.m. on September 18 there was no indication of a typhoon approaching Hong-Kong; and that warning, by the hoisting of the Black Drum on the morning of the 18th, was given as soon as, in the circumstances, was practically possible."

WEATHER REGARDED AS A FUNCTION OF CLIMATE.

By L. C. W. BONACINA, F.R.Met.Soc.

[Read April 17, 1907.]

To all who take a scientific interest in the study of the atmosphere, the words "weather" and "climate" denote two very distinct ideas, and all meteorologists could frame a more or less satisfactory definition of what these terms signify.

When the atmospheric conditions remain nearly normal for any length of time, the changes of weather from day to day, or week to week, being of ordinary character, the idea of climate is always conspicuous in our minds, and may even over-ride that of weather; but when, as occasionally happens, they diverge with respect to one or more elements so widely from the normal as to assume unusual proportions, then the notion of climate is less prominent in our minds than that of weather. For example, a period of bleak, inclement weather in April or May is a normal occurrence and a normal feature of the British climate, and when this happens it merely serves to remind us, provided it is not exceptionally cold, that the spring months in this country are, despite the long days and the relatively high altitude of the sun at noon, backward and treacherous, and characterised by a lingering liability to occurrences of frost and snow; but an outburst of heat, exceptional both with regard to its intensity and to the season in which it is developed, such as marked the opening of the autumn of 1906, is at once regarded as unusual in the annals of meteorology, an extraordinary phase of "weather" that develops despite the efforts of "climate" to prevent it.

It thus appears that it is customary to loosely define climate as the average state of the weather from all causes, or the average changes of weather from all causes over a given area of the earth's surface. This is an excellent working definition, but true for practical purposes only, and theoretically it is incomplete, as will be shown later.

There is, indeed, another method of interpreting the meaning of "weather" and "climate" which it is the purpose of this paper to propose; but, before it is indicated, the nature of what we call "weather" must be briefly referred to, and the known factors of what we call "climate" recapitulated.

In the first place, it is legitimate to assume that weather is, directly or indirectly, a functional product of the distribution of atmospheric pressure. It is the sun's rays that initiate inequalities and changes in the distribution of pressure over the globe. These inequalities are developed and magnified by the axial rotation of the earth and by other agencies of whose *modus operandi* we are for the most part hopefully ignorant, and which thus give rise, directly or indirectly, to the phenomena of weather and the sequence of its types and phases.

In the case of the higher latitudes of the globe like those to which the British Islands belong, the dependence of the general character of the weather upon the distribution of atmospheric pressure is an obvious truth, especially in winter, when local disturbances due to solar radiation are negligible; but, in reality, it holds true equally well in the case of lower latitude and the equatorial regions as a little reflection will suggest. Take the case of India, for example. During the colder half of the year the temperature in India is sufficiently low not materially to interfere with that distribution of pressure which originates the flow over the empire of the North-east Trade wind.

Speaking generally, the month of May in India is the warmest of the year, the mean temperature in many provinces rising to about 90°; and towards the end of that month or early in June the heat becomes so great as to defeat its own object, so to speak, for, as a result of the high temperature, atmospheric pressure over the heated land becomes permanently reduced, and the South-west Monsoon arises, bringing in its train clouded skies and torrential rains to Bombay and Bengal, and a lowering of temperature during the months of June, July, and August, which otherwise would, of course, be even hotter than May. Now this change of weather is a direct function and effect of the change in the distribution of the pressure over India, for, though the latter change is in this case immediately referable to the disturbing effects of intense and accumulated solar radiation over a large tropical land surface, it is necessary that it should take place before the former change can be induced. Numerous (other) cases could be discussed, when it would be found that even within the tropics weather is often directly, but sometimes indirectly, a functional product of pressure distribution.

This much concerning "weather" being established, the various known factors involved in the formation of "climate" must next be classified. These factors are arranged under the following heads, which are made as comprehensive as possible, so as to include in the smallest possible number of terms all those agencies that are known to enter into the constitution of the climatic conditions of any spot or locality on the surface of the earth:—

1. Latitude of the locality.
2. Altitude of the locality.
3. Geographical position of the locality with respect to land or water, warm or cold ocean currents, mountain ranges, desert or moorland tracts, etc.
4. Geological character of the locality and the nature of its surface covering.
5. The relative frequencies of occurrence of the various modes of distribution of atmospheric pressure affecting the locality.

These five factors, then, must be known before the climate of any locality can be specified, but it is number 5 with which this paper is more particularly concerned. It is, of course, quite obvious that factor 5, namely, the liability to certain types of distribution of atmospheric pressure and the consequent liability to certain phases or types of weather, is a most important agent involved in the formation of the climate of a locality; it should, however, be borne in mind that this very factor may itself derive some of its potency from one or more of the other four.

In order that this point may be elucidated, let the winter climate of Siberia be briefly considered by way of a concrete example. In winter time Siberia is more or less subject to an anticyclonic distribution of atmospheric pressure, which is to be referred, of course, to climatic factor 5 in the classification; but this very development of intense anticyclonic conditions reacting so powerfully upon the winter climate of that country is itself in great measure the result of (*a*) the high latitude of Siberia, referable to climatic factor 1, necessarily involving long nights and a low altitude of the noon-day sun in winter, with consequent low temperature, and *cæteris paribus* increased atmospheric pressure; (*b*) the great area of Siberia and the immense continental mass of which it forms part, referable to climatic factor 3, involving rapid loss of heat during the cold period of the year, with tendency for the establishment of persistent and intense anticyclonic systems over the land. In the case of the climate of Britain, the dependence of factor 5 on any of the others is not quite so prominent as in that of Siberia, and that factor has a considerable part of its origin in causes connected with those general movements of the atmosphere which it is at present beyond the power of science to explain.

If the relative frequencies of various types or phases of weather over any given area, which are related *à posteriori* to various modes of distribution of atmospheric pressure affecting that area, exert so potent an influence upon its climate, forming, in fact, one of the five great factors, what then is the nature of weather itself as it manifests itself at any instant of time over any small portion of the earth's surface?

It is appropriate and customary to describe "weather" as the sum total effect of all the atmospheric conditions co-existing at any given time over any given area of the globe. This sum total effect depends on the same functions as climate itself.

It may be advantageous to remark here that this representation of weather necessarily involves intensity as well as type. There now remains to be formulated a more absolute and comprehensive definition of "climate" than is implied in the ordinary notion of the meaning of the term. The "climate" of any place on the surface of the earth is that set of agencies which (*a*) assigns a relative frequency of occurrence at that place to all the diverse possible phases or types which the weather may undergo, and (*b*) imposes a modification upon the intensity of any phase or type of weather, normal or abnormal, that prevails at that place at any instant of time, being in fact responsible for the precise intensity of the weather at the place at the time.

What now are the theoretical consequences of such a definition? By the terms of the definition it is clear that "weather," or the precise state of the atmosphere at any time and place, must be regarded as a direct function of the "climate" of the place at which it prevails. "Weather," briefly, is a function of "climate." But is climate, or, to speak more properly, are the elementary terms of climate a variable or a constant quantity? For relatively short periods of time the climate of the earth and of any spot upon it appears, no doubt, constant, but the geological records of past ages and the prospects for the future of our planet indicate that climate is in reality variable. So far as can be at present ascertained, there are two causes now operating upon the atmosphere which must in the course of ages effect some profound and continuous change in the climate of the earth, viz.:—(1) the gradual diminution in the intensity of solar radiation consequent upon the cooling of the sun, which will become an efficient cause of climatic change after the lapse of vast epochs when the physical processes by which the sun at present maintains its temperature, in virtue of its very cooling, becomes inoperative; and (2) the gradual diminution in the speed of rotation of the globe upon its axis due to constant tidal action, which must in the far distant future tend to produce a continual variance in the mode of circulation of the atmosphere, which, as is well known, is greatly modified by axial rotation. Now, if weather is a function of climate, any slight change in the climate of the earth and of any portion of its surface occurring in the remote future must necessarily have some effect upon all meteorological conditions that will prevail after the climatic change begins to operate, that is to say, the actual weather experienced at every moment of time after the change begins will be slightly different from what would be experienced if the climate were to remain constant. If "climate" be called the independent variable x, and "weather" be called the dependent variable y, then if we properly arrange the corresponding terms of each, $y = F(x)$; but what the dimensions of $F(x)$ are, and how they will vary as x varies, we can never determine until all the laws which actuate the atmosphere and control its movements are fully unravelled, until the rapidly changing systems of high and low pressure, and the ever varying sequence of meteorological phenomena which they engender, are explained and foretold,—until, in other words, the root and origin of the fifth climatic factor in the above classification is within the grasp of mathematics and physics.

Before this paper is concluded, it may be advisable that some illustration taken from recent weather experienced in England be given to demonstrate more clearly the functional relationship between "weather" and "climate." Any set of past weather conditions would, of course, answer the purpose equally well,—that which accompanied the deep and widespread snows at the close of the year 1906, the disastrous gales of February of the present year, or any other kind of recent weather,—but let that which occasioned the period of very hot weather in the early autumn of 1906 be chosen, as this period was referred to in the beginning of this paper as a striking example of an unusual departure from ordinary weather. During the four days August 31 to September 3, 1906, shade temperatures between 90° and 100° were recorded over a large part of England, and the great heat was remarkable alike for its duration and intensity, and for the late date of its occurrence. Now the particular atmospheric conditions dependent upon a certain particular mode of distribution of atmospheric pressure, probably defined by very narrow limits, which permitted weather of this type and order of intensity to develop over a wide area so late in the season are rare, but they have a frequency of occurrence; mathematically speaking, they would still have a certain frequency of occurrence were they to occur but once in the history of our atmosphere.

But this certain frequency of occurrence is determined by climatic factor 5 in the above classification, and thus it is seen that the spell of hot weather in question agrees with part (*a*) of the definition of climate proposed in this paper. It was the other four climatic factors that then acted upon those particular atmospheric conditions, giving rise to the actual temperatures experienced, and determining the precise intensity of all elements of weather during the hot period under discussion; this agrees with part (*b*) of the definition of climate.

Supposing now that the climate of England were very slightly warmer or very slightly colder than it actually is, then for this very small climatic change we are entitled to assert that a corresponding slight variation in the intensity of the hot weather last autumn would have resulted. For a considerable climatic change this deduction is not valid, and if the climate of England were appreciably either warmer or colder than it actually is, the general type of weather responsible for the abnormal outburst of high temperature last autumn might never have occurred at all, or not at any rate precisely when and where it did.

It is hoped that this illustration will serve to render clear what is really meant by representing weather as a function of climate.

It may seem that in the given classification of climatic factors many have been omitted; but if the terms of the five factors given were expanded they would be found to embrace all known influences.

Furthermore, let it be observed that great care has sometimes to be exercised in discriminating between a factor or cause of weather or climate, and effect or manifestation of the same.

For instance, the direction and force of the wind are not infrequently urged as factors of the weather and climate of a given place; but wind is itself a part of weather or climate as experienced at a given place, although it is a factor of other meteorological elements, and hence not it, but its origin, should enter into the classification of factors. Again, diurnal and other periodic variations of meteorological elements are themselves manifestations of weather and climate, and enter into their composition; hence they themselves are not designated factors, as they have their ultimate origin in such factors as have been discussed.

It should be noted that throughout this paper the term "factor" has been employed to denote a primary cause of the sum total effect of weather or climatic conditions without reference to any particular meteorological element, and that, consequently, such agencies as, for example, the various characteristics of wind, which are factors of certain elements of weather and climate, but are themselves part of the total effect of weather and climate, have been systematically excluded as "factors" according to this sense.

[*N.B.*—For rough usage, the definition of climate given above could be curtailed as follows:—Climate is that system of physical agencies which gives rise to the varying atmospheric phenomena denoted by the term "weather," in relation both to frequency of type and intensity of elements.]

DISCUSSION.

Dr. W. N. **Shaw** welcomed the paper as dealing with the philosophy of the science, and therefore an agreeable change from the more usual discussion of concrete observations. He expressed doubt as to whether the representation of weather as a function of climate could be regarded as applicable to the conventional numerical expressions of the various elements of climate which had been generally adopted in meteorological work.

Mr. R. **Strachan** remarked that he had read the paper, and thought that the long and the short of it was that climate meant the integration of weather. When the transcendental mathematician and meteorologist could furnish the differential equations for weather, their integration would give the climate. This was not at all likely to come to pass.

Mr. J. E. CLARK pointed out one thing of importance. Attention was called to the fact that weather was only one of five important functions in the question of climate. They might just as well have said that the weather itself was dependent upon each of these other four,—latitude, altitude, and locality, geographical position regarding land and sea, and so on. Climate was an integration of the various episodes of weather.

Mr. W. W. BRYANT said that the question as to a possible slow change of climate was one which often came up. He generally replied that they had no information showing it, as the mean temperature was not a very safe guide. Last year the phenomenal hot spell occurring late in the year might be caused by a very slow change in the mean temperature. August 21 was about the last date on which—in the first fifty years of Greenwich temperatures—the maximum of the year had ever occurred. In 1895, 1898, and 1906 the highest temperature occurred later than that: in 1898 on September 8, in 1895 on September 24, and in 1906 on August 31.

Mr. L. C. W. BONACINA, in reply, said that Dr. Shaw stated that he did not think that an element of weather like temperature, for example, could be regarded as a numerical function of climate. It is true that any number of degrees of temperature as such could not be called a numerical function of climatic agency, but the amount of heat in the atmosphere represented by that number of degrees of temperature could.

The following explanation might serve to render this clear :—Let us consider for the sake of argument the total amount of solar radiation that falls upon the atmosphere over any given area of the county of London between 12 and 1 p.m. on April 17. This quantity of radiant energy or heat, which we may call x, is an element of climate, and depends on climatic factor (1) in the classification given in the paper; part of it will penetrate the atmosphere and reach the ground (the amount, of course, depending on the condition of the atmosphere, *i.e.* on the kind of weather prevailing), and being absorbed by the ground will become effective in raising the temperature of the air. This rise of temperature suffered by the atmosphere is an element of weather, and it is the amount of heat which the atmosphere has gained, represented by this rise of temperature, which is to be regarded as a function of x. Let the amount of heat represented by this rise of temperature be called y or $F(x)$. The actual magnitude of y depends, of course, on the amount of x which penetrates the atmosphere, becomes absorbed by the ground, and communicated to the air. Arguing in the same manner for a similar area a little farther south than London, say an equal area in the county of Surrey, we must ascribe to x a small positive increment δx, and to y or $F(x)$ for the same atmospheric conditions a small positive increment δy or $\delta F(x)$. It is probable that the ratio between x and $F(x)$ is fixed only for very small positive or negative increments of x, and that for large increments the ratio changes. In the case of an area in the south of France, for instance, where the value of x is considerably greater than it is in England, the ratio between x and y or $F(x)$ is probably different. This is the same as saying that the graph of the equation $y = F(x)$ is a complicated curve. Our ignorance of the physics of the atmosphere, however, precludes certain knowledge on the point.

Respecting Mr. Bryant's remarks that figures failed to show the smallest indication of climatic change in the space of 70 years, Mr. Bonacina said that his paper did not suggest that they did, and that the sources of climatic change referred to in the paper could not produce any apparent effect for millions of years. Further, the statement of his paper was not to the effect that the hot weather of last autumn was the result of any climatic change.

The PRESIDENT said that he was sure they would wish to convey to Mr.

Bonacina the thanks of the Society for bringing forward this paper, which furnished a variety from the subjects which were usually discussed. He thought an occasional change of this kind was extremely good for them. Next time they would try to induce Dr. Shaw to speak at an earlier hour, and see how far his most interesting excursions into the philosophy of meteorology would lead. They might congratulate themselves on this meeting having presented to it papers which had given rise to an unusually varied and agreeable series of discussions.

The Summer and the Autumn of 1768.

Mr. Richard Bentley has collected the following interesting notes on the weather of the summer and autumn of 1768 :—

June.—Frequent thunderstorms and much rain. Fruit both in garden or field suffered greatly, hops were blasted, apple crops damaged, even clover grass blighted. Owing to incessant rains, meadows overflowed and grass was ruined, and the farina of the forward wheat was washed off. Cherries advanced to plumpness, rotted and withered away.

July 1.—The lightning for many miles round London was very dreadful. A metal statue in the garden of a gentleman at Camberwell was melted by it. The water of the Thames above Bridge was so driven out of its channel that one-half of the bed of the river was uncovered for two tides. [A cloud-burst about the same date at Mayence destroying houses and some small bridges.]

July 24.—" Darkness so great on Sunday the church service at Selkirk in Scotland was stopped, the thunder rolled perpetually, lightning flashed through the streets, hail fell so thick and fast that it beat down man and beast. Two men struck by lightning near the bridge, and a thunderbolt ploughed up the ground, making a big hole deep enough to contain the mainmast of a 'first-rate.' At Farnahe the lightning threw up the windows (?), and greatly alarmed the family. The Tweed was in flood, the hay in the adjacent meadows was swept off, and stones weighing tons were rolled down the stream, which bore with it floating carts and cart-wheels, etc."

August 2.—Thunder and lightning in the neighbourhood of London terrifying. Several houses set on fire. A man killed on a coach-box, his watch shivered to atoms, a small hole in the crown of his hat, and a kind of seam down his breast.

On the same date a waterspout suddenly fell on Dungavel Hill, about six miles south of Lanock in Scotland, and forced a way into the ground until it came to the rock, making an aperture about seventy-two feet broad by about three feet deep. The torrent then tore down the north face of the hill, scoring out a path of the same dimensions down the decline, hurling big stones out of its track, and carrying with it large quantities of earth.

August 18.—A Mrs. Dowsett at Good Easter, in Essex, heard about noon a sound resembling thunder, and then witnessed thick smoke arising from a meadow near her house. She heard a violent wind, which lifted off the thatch of a large barn near her. Some of the thatch was carried two miles almost to Pleshy. In an adjoining farmhouse all the pewter utensils were shaken off the shelves.

"During July and August the storms of lightning and thunder, accompanied by rain, have been so fatal in many parts of the island that no man living can remember the like !" [Then follow accounts of great destruction in Lancashire, Gloucestershire, South Wales, Somersetshire, Wiltshire, Norfolk, Hertfordshire, etc., also of floods from Perth to Inverness.]

August 24.—Great heat and drought at Rome. At Naples the drought lasted the whole summer, and caused provisions to reach exorbitant prices.

September 1.—"The heaviest rain fell in London and the country around it that has been known in the memory of man." It began in the evening, and in a few hours the waters poured down Highgate Hill with incredible violence; the sewers not being able to carry off the torrent, the adjacent houses were overflowed to the first floors. The Serpentine river in Hyde Park rose so high that it swept away part of the wall and poured into Knightsbridge—the canal in St. James's Park rose higher than was ever known. The Treasury was cut off, the sentries were driven from their posts, one side of St. James's Park and the Birdcage Walk were under water, and the Earl of Suffolk's house had four feet of water in it. The water at Bagnigge Wells [now King's Cross] rose eight feet. At Hockley-in-the-Hole [Clerkenwell] the inhabitants were driven into the upper storeys of the houses. The rain lasted about eight hours. The Duke of Cumberland's waterworks in Windsor Forest were entirely swept away, and damage was done in Windsor Great Park and the surroundings to the extent of £9000. The navigation of the Thames was stopped, and its banks were so flooded in Berkshire that the West Country barges could not venture up to London. At Marlow the river was over a mile wide.

At Bruton (Wilts) the river rose three feet in five minutes, and the town bridge was partly torn down.

September.—"Last Friday a waterspout fell at Langton (Dorset) and unroofed seven houses and three barns. It was observed to rise over the sea near Abbotsbury."

October.—A large sun-spot visible. A terrible storm at Laval on the Main. "Pieces of ice fell in different forms weighing from eight to thirty-two ounces."

October 14.—A disastrous and sudden inundation near Brenchley, Kent.

October 25.—Great hurricane in Cuba.

November 11.—Thirty-six hours' rain at Birmingham, causing great floods in the surrounding country.

November 19.—Heavy rainfall and snow for thirty hours near Nottingham. Whole flocks of sheep swept away by the sudden rising of the waters. At Chapel-en-le-Frith the snow lay three feet deep.

November 21-23.—A singularly low barometer reported of 28 inches from Worcester, and 27½ inches from Exeter.

December 5.—Great floods round London owing to "the late heavy rains," especially in the valley of the Lea. The Exeter coach was washed off the road near Staines, and all the inside passengers were drowned, and also the four horses. The outside passenger, coachman, and guard were swept away more than half a mile before they were rescued. The North Mail of Saturday reached London a day late; the Gloucester Mail was ten hours behind. Nearly a thousand men were set to work in Suffolk alone to repair the roads.

December 21.—An earthquake felt at Worcester and at Gloucester. The cathedral in the latter city was perceptibly shaken. Birds rushed out of hedges in terror in great numbers. The time was between 5 and 6 p.m.

Fuller details of the above and similar events will be found in the *Annual Register* for 1768, and other journals of that time.

REPORT OF THE COUNCIL

FOR THE YEAR 1906.

[Submitted to the Annual General Meeting, January 16, 1907.]

In presenting the Fifty-sixth Annual Report to the Society, the Council desire to refer with satisfaction to the marked and increasing interest in Meteorology which has been apparent throughout the country. The scheme of Lectures to local Societies has proved successful; there is reason to hope that it will lead to a substantial advance in the study of those scientific principles which it is the duty as well as the privilege of the Society to promote. It is a matter of satisfaction to add that the number of Fellows on the roll has been well maintained.

Committees.—The Council have been materially assisted during the year by the following Committees:—

Editing Committee.—The President, Messrs. Bayard, Inwards, and Scott.

General Purposes Committee. — The President, Secretaries, Treasurer, Messrs. Inwards, Latham, Shaw, and Wilson-Barker.

Kite Committee (to co-operate with other bodies for the promotion of the study of the Upper Atmosphere).—The President, Secretaries, Col. Capper, Mr. Curtis, and Capt. Hepworth.

Local Scientific Societies Committee.—The President, Secretaries, Treasurer, Messrs. Clark, Druce, Hopkinson, and Mellish.

Special Finance Committee (to report upon the financial position of the Society, and any change of organisation desirable in the work of the office).—The President, Treasurer, Messrs. Bayard, Druce, Ellis, and Mellish.

Co-operation with the Meteorological Office.—At the invitation of the Director of the Meteorological Office, the Council appointed the President and Mr. Bayard their delegates to attend a Conference of representatives of the Meteorological Committee, the Royal Meteorological Society, and the Scottish Meteorological Society, for the purpose of considering whether, in lieu of the separate issue of monthly summaries for their several stations, the various authorities could co-operate in the preparation of a joint publication of monthly meteorological summaries of Observations for the British Isles. The result of this Conference has been a definite proposal for a joint publication. The Council have expressed their general approval of the scheme, provided that suitable arrangements can be made for carrying it out. In the event of an agreement being arrived at, the *Meteorological Record* will be brought up to the date of the commencement of the co-operation, and then be merged in the joint publication.

Lecture.—At the request of the Council, a Lecture on "South Africa as seen by a Meteorologist," illustrated by numerous lantern slides, was given on March 21 by Dr. H. R. Mill, and was much appreciated by a large audience.

Howard Medal.—The Howard Silver Medal, open to the Cadets of the Nautical Training College, H.M.S. *Worcester*, was awarded to Cadet J. A. P. Blackburn for the best essay on "The Storm Areas of the Ocean." This essay will be printed in the *Quarterly Journal*, in order to give some idea as to the amount of knowledge on the subject acquired by the candidates for this Medal.

Kite Committee.—This Committee co-operates with a Committee of the British Association and with the Meteorological Office. The Government Grant Committee made a grant of £50 for the purchase of apparatus in connection with Kite Observations to be carried out by Mr. G. C. Simpson in Derbyshire. Mr. Simpson, having been appointed Chief Assistant to the Meteorological Reporter to the Government of India, has been prevented from doing much of the work; but, fortunately, arrangements have been made by Prof. Schuster, F.R.S., to continue the observations. The sum of £75 has been expended in the purchase of winding gear. The Committee anticipate that the report on the recent observations will be presented to the Society in the course of the current year.

The British Association has reappointed its Committee to co-operate with the Kite Committee, but has not made any grant. The Committee have, however, received contributions of £25 each from Mr. Thomas Thorp and from an anonymous donor, which generous help they cordially acknowledge.

Local Scientific Societies Committee.—In connection with the Society's scheme for diffusing a knowledge of Meteorology, Mr. Marriott has during the past year delivered Lectures at twenty centres in various parts of the country. An Exhibition was also arranged in connection with the Royal Horticultural Society's Show at Holland House, Kensington, on July 10 and 11, and at the Sidcup Literary and Scientific Society's Conversazione on November 8.

Representation at Scientific Meetings Abroad.—The American Philosophical Society invited this Society to send representatives to the celebration of the 200th anniversary of the birth of its founder, Benjamin Franklin, at Philadelphia, on April 17 to 21, 1906. The Council were fortunate in securing as the representative of the Society Sir George Darwin, K.C.B., F.R.S., who presented a letter of congratulation signed by the President.

The Royal Geographical Society of Australasia invited the Society to send a representative to the 21st anniversary of the Foundation of the Queensland Branch, to be held at Brisbane in June. As it was not practicable to send a representative, the President wrote a letter of congratulation, which has been duly acknowledged by the Brisbane Society.

The Belgian Government invited the Society to send a representative to the first Congress for Polar Exploration and Research, at Brussels, in September. Dr. H. R. Mill attended on behalf of the Society and took part in the deliberations, a report on which was read at the Meeting of the Society on November 21.

Research Fund.—This fund is represented by £72 : 11 : 5 Consols. No grants from it have been made during the year.

Meetings.—With the exception of those in February, May, and June, which were held in the Society's Rooms, the Meetings took place as usual, by the courtesy of the President and Council of the Institution of Civil Engineers, at their house in Great George Street, Westminster.

The attendances at the Meetings during the past twelve sessions have been as follows :—

Session.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	Total.
1894–5 . .	47	48	65	41	120	73	59	35	488
1895–6 . .	47	48	81	41	139	43	45	34	478
1896–7 . .	45	50	58	36	152	37	46	50	474
1897–8 . .	51	33	69	30	164	37	46	39	469
1898–9 . .	46	40	53	44	29	31	33	29	305
1899–1900 . .	35	44	40	34	31	71	36	38	329
1900–1 . .	35	39	95	47	99	41	40	32	428
1901–2 . .	45	31	49	36	46	123	44	27	401
1902–3 . .	31	32	56	34	150	40	45	47	435
1903–4 . .	41	46	71	38	85	32	42	34	389
1904–5 . .	89	37	58	36	130	35	33	39	457
1905–6 . .	37	43	54	46	151	44	36	32	443

Publications.—The volume of the *Quarterly Journal* for 1906 consists of 306 pages, and contains the papers read at the Meetings of the Society, with an abstract of the discussions that followed, correspondence, and numerous notices of meteorological interest, including the translations by Dr. R. H. Scott of four important papers from the *Meteorologische Zeitschrift.* The section of "Meteorological Literature" has been continued.

Three parts of the *Meteorological Record* have been issued during the year, bringing the publication up to December 1905.

A sixth edition of *Hints to Meteorological Observers* was published on January 1. Mr. Marriott has made considerable additions in order to bring it up to date, and also to render it as helpful as possible to meteorological observers, and his work has been approved by the Council.

In order to meet a want experienced in connection with the Society's Exhibits, a popular pamphlet bearing the title *Some Facts about the Weather* has been prepared by Mr. Marriott and issued for sale. The Council believe that this new publication will prove useful in attracting more attention to the many problems on which the study of Meteorology throws light.

Advertisements.—The Council have appointed Messrs. Van, Alexander & Co. as agents for advertisements in the publications of the Society.

Stations.—Owing to the removal or death of the observers, observations from the stations at Eastbourne, Sussex; Llanbedr, Merioneth; and Winterslow, Wiltshire, are no longer received. The Council have accepted observations from the following new Climatological stations :— Broughton, Hampshire; Chickerell, Dorset; Isfield, Sussex; Lechlade, Gloucestershire; Matlock, Derbyshire; and Sandown, Isle of Wight.

Inspection of Stations.—All the stations south of latitude 52° N. and east of longitude 2° W., as well as such others as could be conveniently visited, were inspected and found to be on the whole in a satisfactory condition. Mr. Marriott's report will be found in Appendix II. p. 231.

Phenological Report.—This valuable report was prepared as usual by Mr. E. Mawley, and read at the February meeting. The Society owes its best thanks to Mr. Mawley for his labours in collecting and discussing the returns of 117 stations, an increase on the previous year, and for keeping in communication with so large a body of special observers during so many years.

For Continuation of Report of the Council, see page 230.

APPENDIX

STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.

Balance from 1905				£202	15	3
Subscriptions for 1906	£847	0	6			
Do. for former years	66	0	0			
Do. paid in advance	50	0	0			
Life Compositions	210	0	0			
Entrance Fees	59	0	0			
				1232	0	6
Meteorological Office—Copies of Returns	£99	6	4			
Do. Grant towards Inspection Expenses	25	0	0			
				124	6	4
Dividends on Stock (including £47 : 19 : 10 from the New Premises Fund)				144	8	4
Sale of Publications, &c.	£59	0	3			
Do. Surplus Stock and non-meteorological Books	15	2	9			
				74	3	0
Advertisements				9	0	0
				£1786	13	5

I.

FOR THE YEAR ENDING DECEMBER 31, 1906.

EXPENDITURE.

Journal, &c.—		
Quarterly Journal, Nos. 137 to 140	£156 15 6	
Illustrations	19 1 6	
Authors' Copies	14 14 6	
Meteorological Record, Nos. 97 to 100	85 12 3	
		£276 3 9
Printing, &c.—		
General Printing	£32 11 9	
Stationery	19 3 6	
Books and Bookbinding	18 0 10	
Observation Forms and Books	20 11 6	
"Hints to Meteorological Observers," 6th Edition	79 15 0	
"Facts about the Weather"	21 17 9	
List of Fellows	16 18 6	
		208 18 10
Office Expenses—		
Salaries	£583 11 2	
Rent	212 0 0	
Coals, Lighting, and Insurance	14 8 5	
Furniture and Repairs	5 4 5	
Postage	78 16 7	
Petty Expenses	19 1 3	
Refreshments at Meetings	13 8 0	
		926 9 10
Observations—		
Inspection of Stations	£42 2 10	
Observers	11 4 0	
Instruments	11 1	
		53 17 11
		£1465 10 4
Balance—		
At Bank of England	£304 6 10	
In hands of the Assistant-Secretary	16 16 3	
		321 3 1
		£1786 13 5

Examined, compared with the vouchers, and found correct,

T. P. NEWMAN, }
J. W. FORRESTER, } *Auditors.*

January 9, 1907.

APPENDIX

ASSETS AND LIABILITIES

LIABILITIES.

Subscriptions paid in advance	£50 0 0	
Rent for quarter ending December 25, 1906	53 0 0	
		£103 0 0
Excess of Assets over Liabilities		3477 2 8
		£3580 2 8

WM. MARRIOTT, *Assistant-Secretary.*

NEW PREMISES FUND,

Interest received on Investment	£47 19 10

RESEARCH FUND,

Balance in hand from 1905	£1 14 0
Interest on Investment	1 14 0
	£3 8 0

I.—continued.

ON DECEMBER 31, 1906.

ASSETS.

Great Central Railway 4½ per cent Debenture Stock, £800 at 126⅝ x.d.	£1013 0 0	
New South Wales 4 per cent Inscribed Stock, £654 : 18s. at 107½	704 0 4	
London & North-Western Railway Consolidated Stock, £400 at 153	612 0 0	
London & North-Western Railway 4 per cent Preference Stock, £12 at 117	14 0 9	
Annuities, 2½ per cent, £231 : 11 : 9 at 84½	195 13 10	
		£2538 14 11
Subscriptions unpaid, estimated at	£50 0 0	
Entrance Fees unpaid	9 0 0	
Interest due on Stock	54 18 3	
Meteorological Office—Weekly Returns, 1906	28 5 3	
		142 3 6
Furniture, Fittings, &c.	£455 13 4	
Instruments	122 7 10	
		578 1 2
Cash at Bank of England	£304 6 10	
Cash in hands of the Assistant-Secretary	16 16 3	
		321 3 1
		£3580 2 8

Examined, and Securities seen at the Bank of England,

January 9, 1907.

T. P. NEWMAN, J. W. FORRESTER, } *Auditors.*

DECEMBER 31, 1906.

Amount paid to the Society's Fund towards the rent of offices at 70 Victoria Street	£47 19 10

Note.—The Society holds on account of this Fund £1443 : 7 : 9 South Australian 3½ per cent Inscribed Stock.

Examined,

January 9, 1907.

T. P. NEWMAN, J. W. FORRESTER, } *Auditors.*

DECEMBER 31, 1906.

Amount invested in the purchase of £3 : 18 : 8 Consols	£3 8 0

Note.—The Society holds on account of this Fund £72 : 11 : 5 Consols.

Examined,

January 9, 1907.

T. P. NEWMAN, J. W. FORRESTER, } *Auditors.*

APPENDIX

SYMONS MEMORIAL

Balance in hand from 1905	£37 6 11
Interest received on Investment	18 18 0
	£56 4 11

LOCAL SCIENTIFIC SOCIETIES

Balance in hand from 1905	£132 6 6
Lectures—Fees and Expenses	61 7 6
Exhibits—Fees and Expenses	13 6 0
Contribution—Mr. J. Hopkinson	1 1 0
	£208 1 0
Interest on Deposit	3 11 11
	£211 12 11

KITE OBSERVATION

Balance in hand from 1905	£49 8 1
Grant from the Royal Society Government Grant Fund	50 0 0
Contribution—Mr. T. Thorp	25 0 0
Do. Anonymous Donor	25 0 0
	£149 8 1

I.—continued.

MEDAL FUND, 1906.

Gold Medal, 1906	£25 0 0
Cash at Bank of England, December 31, 1906	31 4 11
	£56 4 11

Note.—The Society holds on account of this Fund £630 Cardiff Corporation Redeemable Stock, 3 per cent.

Examined,

January 9, 1907.

T. P. NEWMAN,
J. W. FORRESTER, } *Auditors.*

FUND, 1906.

Lecturer's Fees and Expenses	£43 10 11
Exhibitions	12 17 4
Lantern Slides and Diagrams	10 2 1
Printing, Postage, etc.	5 6 1
	£71 16 5
Balance—	
Deposit at London and Westminster Bank	100 0 0
Interest on ditto	3 11 11
Cash at Bank of England	28 16 10
Do. in hands of Assistant Secretary	7 7 9
	£211 12 11

Examined,

January 9, 1907.

T. P. NEWMAN,
J. W. FORRESTER, } *Auditors.*

FUND, 1906.

Kite Winch	£75 0 0
Cash at Bank of England, December 31, 1906	74 8 1
	£149 8 1

Examined,

January 9, 1907.

T. P. NEWMAN,
J. W. FORRESTER, } *Auditors.*

Special Finance Committee.—The increase of the routine work of the office, arising from the additional duties which the Society has undertaken during the last few years, made it desirable to appoint a special Committee to investigate all matters in connection with the office work and its bearings on the finance of the Society. Amongst the recommendations made by the Committee which the Council have adopted are (1) the replacement of one of the junior members of the staff by a typist and shorthand clerk (Dr. Williams has generously presented the Society with a Remington typewriter), and (2) the recommendation that the life composition be raised from £21 to £25, and that Fellows of more than 10 years' standing may compound for £20, and those of more than 20 years' standing for £12.

A resolution will be submitted at the Annual General Meeting for the necessary alteration of By-Law 15.

Library.—The additions to the Library are given in the Appendix. The Library now consists of the following:—Volumes, 8731; Pamphlets, 12,223; Maps and Charts, 217; Manuscripts, 896; and Original Observation Books, 140. Progress has been made with the revision of the Catalogue. Guide cards have been put in the Authors' Catalogue to the letter R. As the serials in the Library have overgrown the accommodation provided for them, it has been decided to eliminate those of a non-meteorological character. Additional shelf accommodation will, nevertheless, have to be provided, and this will necessitate a rearrangement of the books.

Meteorological Bibliography.—During the year 6026 cards have been prepared for the Society's Bibliography, which, in continuation of the Symons' Bibliography, consists of the titles of all books, pamphlets, papers, and articles bearing on Meteorology of which any notice can be found. In addition to the above, 803 catalogue cards of the titles of works bearing on Meteorology published in the British Isles have been made for the *International Catalogue of Scientific Literature.*

The Council have to express their recognition of the courtesy of the Editor of the *Geographical Journal* for supplying advance proofs of the monthly Bibliography prepared for that publication.

Fellows.—The changes in the number of Fellows are given in the following table:—

FELLOWS.	ANNUAL.	LIFE.	HONORARY.	TOTAL.
1905, December 31	**511**	**146**	**17**	**674**
Since elected . . .	+ 54	+ 9	+ 3	+ 66
Since compounded .	− 1	+ 1	...	0
Reinstated	+ 1	...	...	+ 1
Deceased	− 7	− 7	...	− 14
Retired	− 26	...	...	− 26
Removed from List .	− 19	...	...	− 19
Lapsed	− 13	...	...	− 13
1906, December 31	**500**	**149**	**20**	**669**

Deaths.—The Council regret to have to record the loss by death of fourteen Fellows.

Charles Lowthian Bell	elected	Nov. 18, 1903.
Thomas Naish Blake	,,	Dec. 19, 1888.
Hon. Charles Arthur Ellis, F.L.S.	,,	Dec. 18, 1896.
Robert Isaac Finnemore, J.P., F.R.A.S., F.R.G.S.	,,	Nov. 18, 1891.
William Henry Goss, F.G.S.	,,	Apr. 20, 1881.
Capt. William Nelson Greenwood	,,	Feb. 15, 1882.
Henry George Hollingworth, F.R.G.S.	,,	Nov. 17, 1897.
George Paul	,,	Nov. 16, 1904.
Edwin J. Pearson, J.P.	,,	Apr. 17, 1895.
William Peregrine Propert, M.A., LL.D., M.B., F.G.S.	,,	Feb. 18, 1880.
John Robinson, J.P. (died in 1903)	,,	May 20, 1891.
Col. Francis R. Waldo Sibthorp, F.R.G.S.	,,	Dec. 19, 1900.
William Sowerby, F.L.S.	,,	June 17, 1863.
Norman Wrigley, F.R.G.S.	,,	Feb. 19, 1902.

Finance.—The Accounts of the Society for the past year, duly audited, are given on pp. 224-229.

APPENDIX II.

INSPECTION OF STATIONS, 1906.

The stations in the south-east of England, as well as a few others, have been visited, and have been found to be generally in a very satisfactory condition.

The number of thermometers tested has been 208, in 68 of which there was found to be a change of zero.

Two new rain-measuring glasses have also been tested, one of which was not properly graduated.

Considerable difficulty has been experienced by the observer at Old Street, owing to the instruments being interfered with, and sometimes broken by mischievous boys climbing over the railing into the churchyard. It has consequently been necessary to move the thermometer screen and rain-gauge to a more secluded spot, where the exposure is not so good as formerly.

During my inspection I found that at two stations an additional sunshine recorder was placed in another part of the town, and that it was the custom to quote the larger amount given by one or other of the recorders as the sunshine for the day. I do not consider this to be a satisfactory method. The records from only one and the same instrument should be used.

I should like to impress upon all second-order observers the desirability of using a thoroughly efficient lamp for the night observations, and to see that it is kept properly trimmed and always ready for use.

Wm. Marriott.

October 1906.

NOTES ON THE STATIONS.

Addington, *August* 14.—This station was in good order. On comparing the thermometers, it was found that the maximum had gone up 0°·2. The observations are made by the Park Keeper, who takes a great interest in them.

Beddington, *August* 10.—This station was in good order. The dry bulb, wet bulb, and maximum thermometers were found to have gone up 0°·2.

Bennington, *August* 28.—This station was in good order. I suggested that a new Snowdon rain-gauge be substituted for the existing one. The Jordan sunshine recorder was about 10 minutes slow in time. A tree on the west makes an angle of 6° with the sunshine recorder. On comparing the thermometers, it was found that the dry bulb, wet bulb, and minimum had gone up 0°·2, and that the 4 ft. earth thermometer had gone up 0°·3.

Berkhamsted, *August* 29.—Mr. Mawley has all his instruments overhauled and cleaned by a competent man once a year, so the station is always kept in good order. The ball of the sunshine recorder was not quite in the centre of the frame, being too near the eastern side. Possibly the trees and a new house on the east may cut off a little sun in the early morning. On comparing the thermometers it was found that the dry bulb and wet bulb had gone up 0°·1, and that the minimum and the 2 ft. earth thermometer had gone up 0°·2. Mr. Mawley has a large range open scale Richard thermograph, a fresh sheet being put on each day.

Bognor, *July* 31.—This station was in good order. The 4 ft. earth thermometer is a Six's maximum and minimum. I found it difficult to test this instrument, as the column of mercury became divided while carrying the instrument. I, however, subsequently readjusted it. A Campbell-Stokes recorder has been started in addition to the Jordan recorder. The glass ball is cemented to the pedestal. I urged that the recorder be fixed, so as not to be liable to be shifted. On comparing the thermometers it was found that the dry bulb and wet bulb had gone up 0°·1.

Brighton, *August* 1.—The board on which the barometer was hung required readjusting, so as to allow the instrument to hang quite vertically. A wooden button is needed for keeping the board of the dry and wet bulb thermometers from moving in windy weather. A new maximum thermometer was obtained some months ago. The instrument seemed to work all right, but it required a good deal of shaking to set it; the observer evidently should not be in a hurry when doing so. The rain-gauge was too close to the trees; I recommended that it be moved about 20 ft. further to the west. The sunshine recorder is on the top of the Town Hall, and has a very good exposure. It was 10 minutes fast in time. The stand needed fixing to prevent shifting. There are two other recorders, namely, one at the Race-Course, and the other at the Sanatorium. It was the practice for some time to give the greatest amount of sunshine from any of the three; I advised that the amount should only be taken from the recorder on the Town Hall. On comparing the thermometers, it was found that the dry bulb had gone up 0°·1, the wet bulb and minimum had gone up 0°·2, and the grass minimum had gone down 0°·4. The earth thermometer, which is a spirit one, is graduated from − 25° to + 125°.

Broughton, *July* 27.—This station is at the Boys' School, and is about 4 miles east of that at Roche Court, Winterslow. I made several suggestions with regard to the exposure of the instruments, in order to make the station a suitable one for replacing that at Roche Court, which was shortly to be discontinued. Mr. Upshall's thermometers, however, were not graduated on the tubes. I promised, however, if possible to lend him a set of standard instruments, so as to equip the station thoroughly.

Buxton, *March* 1.—I called to see the observer, and had some conversation with him about the returns. I went round with him at 9 p.m., and saw him take the evening observations. He used matches for reading the instruments. I pointed out that this practice was not to be commended, and urged that a good lamp should always be used. The barometer, which has been thoroughly cleaned, is now placed inside the hospital building.

Chelmsford, *August* 16.—There was no change in the instruments at this station. The thermometer screen required repairing and painting. There was a little spirit at the top of the tube of the minimum thermometer.

Chickerell, *July* 17.—The Rev. S. Poole has taken over the instruments belonging to his brother, the late Rev. H. P. Poole, of Ilton. They are placed on the lawn of the Rectory, but there are several high trees all around. The pipe of the rain-gauge was broken off, and needed re-soldering. The grass minimum thermometer had some spirit up the tube. On comparing the thermometers it was found that the dry bulb had gone up 0°·1, and the maximum 0°·2. The grass minimum appeared to have gone down 1°·5. This station is about three miles north-west of Weymouth.

Cranleigh, *June* 29.—There was no change in the instruments at this station. The wet bulb was wrapped round with several thicknesses of muslin, and the bulb was *in the water* in a large cup. I took this away and rearranged the instrument, and urged that proper attention should be given to the working of the wet bulb. The stems of the dry bulb and wet bulb were loose, and required refixing. The rain-gauge required to be more firmly fixed in the ground. The Science Master has the supervision of the observations, but they are usually taken by the porter. Occasionally the observations are taken by one or two of the senior boys.

Ditcham, *August* 15.—This station is about 4 miles south of Petersfield, and is on the summit of the downs at a height of 550 ft. above sea-level. The instruments are well exposed. I recommended a rearrangement of the thermometers in the screen. As the rain-gauge is in a very open and exposed situation, I suggested that a second gauge be obtained and placed in a less exposed spot.

Dorchester, *July* 16.—The muslin on the wet bulb thermometer required changing. The sunshine recorder was a few minutes slow. There is a row of trees along the road to the south of the recorder, running from north-east to south-west. These make an angle of 20° on the south-south-east, and they cut off the morning sunshine, and also most of the winter sunshine. I recommended that the recorder be placed on the face of the Water Tower at a considerable height above the ground, so as to greatly reduce the angle.

Eastbourne, *August* 2.—The muslin on the wet bulb thermometer required changing. The legs of the screen needed strengthening. On comparing the thermometers it was found that the dry bulb had gone up 0°·1, and that the wet bulb and minimum had gone up 0°·2. It is possible that the observations at this station will have to be discontinued as the house is shortly to be sold.

Folkestone, *August* 22.—The legs of the thermometer screen required strengthening. On comparing the thermometers, it was found that the dry bulb, wet bulb, and minimum had gone up 0°·2. The Jordan sunshine recorder was not set to the proper latitude, the scale being graduated downwards instead of upwards.

Folkestone (M.O.), *August* 22.—This station is in Radnor Park. The exposure is good. I would recommend a rearrangement of the thermometers in the screen similar to that in the *Hints to Meteorological Observers*. The rain-gauge, which is a Negretti and Zambra's self-recording instrument, is mounted on a post, with the rim fully 6 ft. above the ground. It is placed in a public footpath, and is consequently liable to be interfered with. A few hours previous to my visit the instrument showed a fall of ·01 of rain, notwithstanding that the day was beautifully fine and rainless. This was evidently due to children knocking against the post. The Campbell-Stokes sunshine recorder is placed on the roof of a building at the Dust Destructor. The exposure is good. The instrument, however, was not in adjustment. I endeavoured to put it into proper adjustment.

GRAYSHOTT, *August* 15.—On comparing the thermometers it was found that the dry bulb and wet bulb had gone up 0°·1. The inner can of the rain-gauge needed repairing. The ball of the Campbell-Stokes sunshine recorder required readjusting. Mrs. Lyndon has recently started a percolation gauge and has also a barograph.

GUERNSEY, *July* 21.—The instruments were in the same position as at the last inspection. A new maximum thermometer had been obtained, the old one having been broken. The thermometer screen required repairing and painting. I recommended a rearrangement of the thermometers in the screen. There was no can or bottle in the 8 inch rain-gauge. I recommended that one be provided, and that the Snowdon gauge be read weekly instead of monthly. A Campbell-Stokes sunshine recorder was substituted for the Jordan recorder at the beginning of last year. The instrument was working satisfactorily.

GUERNSEY (M.O.), *July* 21.—I called to see Mr. Collinette's station at Fort Road. Everything was in good order. On comparing the thermometers it was found that the dry bulb had gone up 0°·4, the wet bulb 0°·5, the spare dry bulb 0°·1, the spare wet bulb 0°·5, and the spare minimum 0°·3. The Campbell-Stokes sunshine recorder has been removed to special staging, two fields to the eastward at the corner of the Fort grounds. The exposure is very good. The barometer had been sent to the makers to be cleaned, and was at Kew for re-verification. Mr. Collinette is a keen observer and takes great interest in meteorology. He has a barograph and a thermograph, and he prepares a daily local forecast, which is exhibited at the Gilles Library.

HALSTEAD, *August* 16.—There was no change in the instruments at this station. The mercury in the cistern of the barometer was very dirty and required cleaning. Owing to the funnel of the rain-gauge having always been taken off the same way, it had become quite oval. The difference in the measurements was a quarter of an inch. This is the greatest difference which I can remember to have seen anywhere.

HORSHAM (CHRIST'S HOSPITAL), *June* 29.—This station was in good order. On comparing the thermometers it was found that the grass minimum was 1°·2 too low. The minimum had some spirit at the top of the tube.

ISFIELD, *July* 5.—Major King is again supplying the Society with his observations from this station. The instruments were all clean and well arranged. The Jordan recorder was not in proper adjustment. On comparing the thermometers it was found that the dry bulb and wet bulb had gone up 0°·2, and that the earth thermometer had gone up 0°·3. The tube of the earth thermometer required to be driven nearly 2 inches farther into the ground. The evaporation tank is now only read once a month.

MARGATE, *August* 21.—The legs of the thermometer screen required strengthening. On comparing the thermometers it was found that the minimum had gone up 0°·6, and that the 6 inch, 1 ft. and 4 ft. earth thermometers had each gone up 0°·1. An additional 5-inch rain-measuring glass had recently been obtained. On testing it, however, I found that it was graduated too low, and required a correction of ·01 in. The barometer board required refixing, as the instrument was not hung quite vertically. A new frame for the sunshine recorder had been obtained some time ago, the old ball being still used. The recorder was not right for time, the stone on which it was fixed having been moved.

MATLOCK, *March* 2.—Mr. Pilkington, of Buxton, told me that arrangements were under consideration for the starting of a meteorological station at Matlock. At his request I met Mr. Hall and several other gentlemen of the Town Advertising Committee. After discussion, they took me to Rock Hill Hydro, where a site was suggested for the instruments, which perhaps is as favourable a one as can be found, as the ground at Matlock slopes considerably. I suggested that a sunshine recorder should be placed on the roof of the building. The instruments were to be procured and placed in position in the course of a few months' time.

MARLBOROUGH, *June* 28.—There was no muslin on the wet bulb. I urged that this instrument be properly attended to. The cap of the 1 ft. earth thermometer let the rain through into the pipe, and consequently the outer glass tube was much discoloured. The sunshine recorder was not in proper adjustment. I was not able to set it properly, as there was no sun at the time of my visit; but I left instructions how this should be done. A new Robinson anemometer had recently been obtained. Mr. J. C. Alsop takes the readings, and one of the senior boys has charge of the sunshine recorder and the anemometer. Mr. M. Taylor copies out the readings on to the return.

OLD STREET, E.C., *September* 12.—The instruments in St. Luke's Churchyard have frequently been interfered with; and on three or four occasions the Stevenson screen has been damaged and some of the thermometers broken. This has necessitated the instruments being placed in a more secluded spot, consequently the exposure is not so good as formerly. The rain-gauge has also been tampered with, especially in the summer months by boys who have climbed over the railings in order to find caterpillars on the creepers round the church. The observer has consequently had great difficulties to contend with, and has had temporarily to remove the rain-gauge to the back of his house. This is not a satisfactory arrangement, but he has evidently tried to do his best under the circumstances. On comparing the thermometers, it was found that the minimum had gone up 0°·6.

PIRBRIGHT, *September* 13.—When the maximum thermometer was placed in a horizontal position, the mercury in the tube ran up 0°·7 higher than when the instrument was held vertical. I recommended that the thermometer be mounted considerably on the incline, in order to obviate any unduly high readings. The thermometer screen required strengthening. The conducting thread on the wet bulb was only two thin strands. I recommended that it be of 4 strands doubled, in order to ensure a plentiful supply of moisture to the bulb. There was a little water in the rain-gauge, although there had been no rain on the day of my visit. I urged that the rain-gauge should be examined every day.

PORTSMOUTH, *July* 30.—The instruments were in good order. I recommended a rearrangement of the thermometers in the screen. The Jordan sunshine recorder is placed on the top of the thermometer screen, but it does not get the early morning sunshine, as there are high buildings to the eastward. The recorder was not in adjustment for time, being 10 minutes fast. A Negretti and Zambra electrical self-recording rain-gauge had recently been obtained, and the recording part was placed in the Medical Officer's room at the Town Hall, the connecting wires being laid underground.

RAVENSTHORPE [NORTHAMPTON], *August* 30.—The muslin of the wet bulb required changing. The tube of the maximum thermometer had slipped down about 3°; this I readjusted and wedged up with cork. The thermometer screen needed painting. The amount of cloud was not properly estimated; the observer calling blue sky as "2" instead of "0." On comparing the thermometers it was found that the wet bulb had gone up 0°·1, and that the minimum had gone up 0°·3.

REGENT'S PARK, *September* 25.—The thermometer screen required strengthening. I also recommended that the inside of the screen be washed out by syringing. The earth thermometers have long tubes, and have been in use for a number of years. The glasses over the scales are frequently steamed, and so the scales are difficult to see distinctly. There was some water in the rain-gauge, although there had been no rain that day. I urged that the gauge be examined every day. The sunshine recorder required levelling, as the trace was not running parallel with the card. A tree on the south-east appeared likely to cut off a little of the early morning sunshine in the winter, so I recommended that it be topped. On comparing the thermometers it was found that the dry had gone up 0°·1, and that the 6 in., 1 ft. and 2 ft. earth thermometers had gone up 0°·5.

SANDOWN, *July* 28.—The Campbell-Stokes sunshine recorder is placed on the top of the Public Library, and is well exposed. The thermometer screen, which only contains a maximum and minimum, is placed in a passage by the side of the building; and the rain-gauge is also near the building and close to the railings. Both the thermometer screen and the rain-gauge are in unsatisfactory positions. I suggested that a new site for them should be obtained, possibly on the lawn of the Ocean Hotel.

SHAFTESBURY, *July* 25.—The instruments were in the same position as at the last inspection, except that the rain-gauge had been moved near the thermometer screen to permit of croquet being played on the lawn. I moved the gauge a few feet further to the westward. On comparing the thermometers, it was found that the dry bulb and wet bulb had both gone up 0°·2. I instructed the observer in the management of the wet bulb in frost.

SWARRATON, *July* 24.—The muslin on the wet bulb was not working properly. On comparing the thermometers it was found that the dry bulb and wet bulb had both gone up 0°·2. These thermometers have long stems and cylindrical bulbs, and are graduated to two-tenths of a degree.

TENTERDEN, *August* 23.—Mr. Mace has had a tower built to his house, on which he has placed the sunshine recorder. The exposure is very good. The wooden block on which the recorder is mounted had become warped, and the instrument required levelling and fixing. The barometer board required rehanging and fixing in order to keep the barometer always vertical.

TUNBRIDGE WELLS, *July* 5.—The instruments have been moved a few yards further to the westward since the last inspection. The exposure is good. On comparing the thermometers it was found that the dry bulb and wet bulb had both gone up 0°·2, the earth thermometer had gone up 0°·1, the minimum had gone down 0°·2, and the grass minimum had gone down 0°·6. The sunshine recorders were in good adjustment and were working satisfactorily.

Ventnor, *July* 28.—The Fortin barometer was sent to the makers to be cleaned, etc., about two years ago. The mercury in the cistern, however, has again become dirty. On comparing the thermometers, it was found that the minimum had gone down 0°·2. The sunshine recorder was working satisfactorily. I recommended that some shrubs to the east of the recorder be topped. The hill on the west makes an angle of 5°, and on the north-west 7°; a little of the evening sunshine may consequently be cut off.

Wallington, *August* 10.—This station was in good order. On comparing the thermometers it was found that the dry bulb and wet bulb had both gone up 0°·1, the 1 ft. 0°·3, the 2 ft. 0°·4, and the 3 ft. 0°·3, and that the grass minimum had gone down 0°·2. Mr. Bayard has also a barograph and a thermograph at work.

Weymouth, *July* 17.—The instruments had been moved from the Nothe to the Electricity Works at West Ham, which is on the west side of the Backwater. They are placed in a railed-off enclosure. I recommended that grass be laid down in the enclosure. The mercury in the maximum thermometer had a tendency to run up the tube, so I recommended that the instrument be hung more inclined. The sunshine recorder is on the top of the Hotel Burden. It is wound up by an endless chain on a post about 20 ft. high, so as to be clear of the chimneys. The exposure is very good, but the instrument has to be attended to by the porter of the hotel. It is proposed to put the recorder on the top of the house at the Electricity Works. The exposure there is very good, except that the chimney of the works on the south makes an angle of 24°. I suggested that the post and winding arrangement be fixed to the chimney stack, so as to raise the recorder 10 or 15 ft. above the roof, and so nearly clear the chimney.

Woolacombe, *July* 26.—This station was in good order. The instruments are well arranged, and the exposure is very open.

Worthing, *July* 31.—There was some spirit at the top of the tube of the grass minimum thermometer. I recommended a rearrangement of the thermometers in the screen, and also that a new water receptacle be obtained. The lawn on which the instruments are placed is now used as a recreation-ground for the Lady Art Students. It is desirable that a larger area be enclosed for the instruments. The barometer board required fixing securely to the wall. A new sunshine recorder had been obtained and placed on the pavilion at the end of the pier. The instrument was about 5 minutes fast in time. The other Campbell-Stokes recorder and the Jordan recorder are still on the roof of the library. I found that it was the custom to take the largest amount given by one or other of the recorders. This is not a satisfactory method, nor a plan to be recommended; the records from one instrument only should be used. I recommended that the sunshine be taken from the recorder on the library, as it had been going on for a number of years.

APPENDIX III.

OBITUARY NOTICES.

Charles Lowthian Bell was the second son of the late Sir Lowthian Bell, Bart., F.R.S., and was born at Washington Hall, near Durham, on March 24, 1855. He was educated first at a preparatory school at The Mount, North-allerton, and subsequently at Wellington College. After leaving Wellington he proceeded to Paris, and continued his studies at the École des Mines, whence he went to the well-known works of Schneider and Co., at Le Creusot, where he remained about a couple of years. He then returned to England, and, after occupying various subordinate positions in the firm of Messrs. Bell Brothers, he undertook the management of the furnaces at Walker-on-Tyne in the year 1881. Three years later he removed to Clarence as Assistant Manager under Mr. John Thompson. On the death of this gentleman in 1887 he became manager of the Clarence Works, and under his superintendence the whole arrangements were remodelled. He remained in charge of the Clarence Works until 1904. Shortly before his father's death in December of that year he decided to resign his position and to take a less active part in the management, though he remained a director of the Company.

He paid numerous visits to ironworks abroad, both in Europe and America, accompanying his father on one of his visits to the latter country. On the flotation of Messrs. Bell Brothers, Limited, in 1899, as a public company, he and Mr. W. H. Panton paid another visit to America to study the processes of steel manufacture in that country, and they also visited various works in Europe for the same purpose. The information then acquired was utilised in designing the steel plant at Clarence. Already in 1886 the attention of Sir Lowthian Bell and his partners had been turned in the direction of the manufacture of steel from Cleveland iron, and a small plant had been erected under designs, in the preparation of which Mr. C. L. Bell took a large part. A considerable quantity of steel was produced at this establishment; but circumstances prevented the project being carried forward, and for some years the works lay idle. In 1898, by arrangement with Messrs. Dorman, Long and Co., experiments which the latter firm had begun at Rosebery Steel Works, near Middlesbrough, were continued at the works at Clarence, put at the disposal of the firm by Sir Lowthian Bell and his sons. Under the direct supervision of Mr. W. H. Panton, assisted by Mr. C. L. Bell, a series of experiments resulted in a satisfactory solution of the problem, the flotation of the firm as a public company and the erection of the present important plant at Clarence being the direct results of these operations.

Over and above the many activities he displayed in connection with the Works at Clarence (where not only the Iron Works, but also the Salt Works and Soda Works, until they were sold to the Salt Union, and Messrs. Brunner, Mond and Co., respectively, were under his control), he took an active part in the Volunteer movement. He joined the North Riding Volunteer Artillery in 1874, and took command of the corps in 1895 as Lieutenant-Colonel, becoming a year later the Honorary Colonel, resigning his command in 1902 on reaching the age limit. During the South African War he was the means of raising and equipping two Colt-gun detachments and of sending out 400 men for the Imperial Yeomanry. He was for some time a member of the Middlesbrough Town Council, serving the office of Mayor in the year 1893; and he was for many years an active member of the Stockton Board of Guardians. He was on the Commission of the Peace for the North Riding and for the County of Durham, and also for the Borough of Middlesbrough. He died after a very short illness, on February 8, 1906, in his fifty-first year.

He was elected a Fellow of this Society on November 18, 1903.

Robert Isaac Finnemore was the son of the land-steward to the Archbishop of Canterbury. When Mr. Finnemore was eight years old the family emigrated to Natal, taking passage in the ill-fated *Minerva*, which was wrecked off the Natal coast, the family being saved with great difficulty. It was the intention of his parents that he should become a minister, and he studied as a pupil at Bishopstowe under Bishop Colenso. The buildings at Bishopstowe being destroyed by fire, he removed to Maritzburg, where, in 1858, he entered the Government service as pupil-assistant in the Surveyor-General's office. The following year, while not yet seventeen, he was promoted to be second clerk. In 1864 he rose to be chief clerk and draughtsman, and was also admitted a Government land-surveyor. Being of an ambitious disposition, and the Surveyor-General's department offering no prospect of further advancement, he succeeded in being transferred to the Attorney-General's department, where he worked as law-clerk under Sir Michael Galwey for eleven years. In 1876 he accepted the appointment of Postmaster-General. During his tenure of office he introduced separate delivery windows for Europeans and natives, but his attempt to establish a postal delivery was unsuccessful. In 1877 he was appointed Master of the Supreme Court, which post he held till March 1881.

Mr. Finnemore was Chairman of the Zulu War Commission appointed to decide upon the compensation to be paid to relatives of those who had fallen during the war; and for his "admirable report," drafted with the assistance of Sir Henry Bale and Dean Green, he received the thanks of the Government and an expression of the Governor's high appreciation. In 1894 a new office of Crown Solicitor and Parliamentary Draughtsman was created, and the then Prime Minister, Sir John Robinson, offered the post to Mr. Finnemore. It was in this capacity that he, in 1896, accompanied Sir Walter Hely-Hutchinson to Volksrust as legal adviser in connection with the Jameson Raid. In November 1896 he succeeded to the Supreme Court Bench, and during part of 1903 and 1904 he acted as Chief-Justice, and towards the end of the latter year he retired.

Mr. Finnemore did much to advance the cause of philanthropic, religious, and social organisations. He was an enthusiastic Freemason, and held the office of District Grand Master from 1882. To the cause of temperance he devoted much time; and as a member of the Wesleyan Methodist Church he did much for the advancement of that body in Natal. He was, besides, a Fellow of several scientific Societies.

Mr. Finnemore died on July 27, 1906.

He was elected a Fellow of this Society on November 18, 1891.

William Henry Goss was born in London on July 30, 1833. In his early life he was a great student, and at Somerset House, where he spent much of his youthful leisure, he became an artist of some considerable power. He remained in London until he was twenty-four years of age, making at this time acquaintance with most of the best-known literary men of the day. Familiarity with the Staffordshire Potteries was due to the interest of the late Alderman Copeland, who was at the time Lord Mayor of London, and who took an affectionate interest in Mr. Goss, and under whom he learnt the art. He commenced potting on his own account in 1858, and from the first attained a degree of success, the equal of which few local producers have in like measure achieved. In these early days he produced among other kinds of pottery porcelain encrusted with jewels and gold of considerable beauty. A highly coveted award was granted him in 1862 by the jurors of the International Exhibition of that year for the high finish and skill shown in the fabrication of his articles in ivory-porcelain.

As a potter, he will doubtless be remembered longest for the heraldic ware which he produced in great quantities. He also invented the different coloured enamels which are used in the heraldic decorations. The success which he attained in his "bodies" and "glazes" was doubtless to be attributed to the fact that he had made a study of chemistry.

Mr. Goss was a well-known member of the North Staffordshire Field Club.

He was, until recent years, one of the most regular attenders at meetings and excursions, and many interesting papers have been read by him to the members. One of the best known of these papers dealt with the history and topography of Cloud Hill. He likewise wrote a *Sketch of the Life and Death of Llewellyn Jewett*, more than one edition of which has been issued. He had also written interesting sketches of the late Editor of *The Art Journal* (Mr. S. C. Hall) and of Mrs. Hall, and had been a frequent contributor himself to *The Reliquary*. To that scholarly paper he contributed facts concerning the bust of Josiah Wedgwood, on the tomb of the great potter, on Arbor Low, and on his own factory. He also made successful efforts in the writing of poetry.

During the last few years Mr. Goss had practically lived the life of a recluse, interesting himself in reading and writing on subjects of great diversity of interest. His latest publications were a *Review of Modern Science and Modern Thought*, written in the form of letters to his friend, the late Mrs. Anderson, sister of General Gordon; and on *Primitive Man and his Work*, an exhaustive treatise in two volumes. His house at Ashfield Cottage, Stoke-on-Trent, is a veritable museum of curiosities. Mr. Goss had stored in it a large collection of curios, books, armour, pictures, and rare china, the result of a life-long thirst for the beautiful in every handicraft.

He died on January 4, 1906.

He was elected a Fellow of this Society on April 20, 1881.

William Nelson Greenwood was born at Kendal on August 30, 1839. He received part of his education at Heversham Grammar School, and on the death of his father in 1848, his mother being left in reduced circumstances, it became necessary that the lad should find employment, and after some time he was allowed to adopt the maritime calling. His first voyage was taken in 1853 from Liverpool to Quebec in the *Chieftain* of Lancaster, a small barque belonging to the late Mr. J. S. Burrell, an ex-Mayor of Lancaster, and shipowner. While in Mr. Burrell's employ young Greenwood made several voyages, and left it to enter the West India trade. It was at this period that he narrowly escaped death. While trimming the leeward edge of a foresail during a storm he lost his hold of the rope, and just succeeded in clutching a reef point on the fore side of the sail, in which position he hung for nearly five minutes before his rescue could be effected.

In 1862, he obtained the mate's certificate, and afterwards went as second mate in the *Beachworth*, a large Liverpool sailing vessel, in which he was wrecked in the harbour of Bombay. Returning to England in 1864, he qualified for chief mate in Liverpool, and sailed as such for a considerable period. He was mate of a vessel in Pernambuco when an English barque, the *Gustave Adolph*, arrived there. The captain had been shot by the second mate, who afterwards deserted in one of the ship's boats, but was captured and conveyed prisoner to Pernambuco. The vessel not being able to proceed for want of a captain, Mr. Greenwood was appointed to the post, and he took her to China. Coming home to England, he obtained an extra master's certificate, and joined the Cunard line, sailing along with the once famous Capt. Judkins in the steamer *Scotia*. This steamer, with the exception, of course, of the *Great Eastern*, was the largest of the day, and was the last of the old paddle-wheel liners.

Later he took an interest in and commanded the fast sailing ship *Gareloch*, in which he rescued a portion of the crew of the telegraph steamer *La Plata* on November 27, 1874. Her crew was eighty all told, and fifteen were rescued. Two others were found by a Dutch vessel. In spite of a bad beginning this voyage was made to Otago, New Zealand, in 69 days from land to land, or 74 days for the whole voyage. The *Gareloch* had over 400 emigrants on board at the time of the rescue, and much was made of it in the press. The whole incident was worked up in a sea story by a popular sea novelist, and published in the *Boy's Own Paper*.

In 1875 Capt. Greenwood visited Pitcairn Island, the home of the descendants of *The Bounty* mutineers. He found that a plague of rats had destroyed all their corn-seed, and he was not only able to replace the loss, but to give such information about their condition in England as led to remedial measures being undertaken on their behalf. Another visit of great interest was that paid to the island of Tristan d'Acunha.

In 1878 Capt. Greenwood left the sea, and in 1880 accepted the position of Dock-master at Glasson for the Lancaster Port Commissioners, a position he retained until December 31, 1905, when he was appointed Clerk and Harbour-master in succession to Capt. Adam Russell. He, however, only held the new office one month, for he died suddenly on February 1, 1906. In 1883 Capt. Greenwood first published his well-known *Nautical Almanac and Kludonometric Tide Tables*—a comprehensive guide to shipmasters, containing information relating to the more important ports of the world, tidal matters, currents, and other subjects of interest to mariners.

He was elected a Fellow of this Society on February 15, 1882.

Edwin James Pearson was born in London on February 13, 1842, and was the son of the late Sir Edwin Pearson, F.R.S. He was educated at Harrow, and after leaving school entered the Board of Trade, where he served till towards the end of 1884, when he retired on pension on the occasion of a reorganisation of the office.

During his period of service he attended an International Railway Congress at Rome on behalf of the Board of Trade; and he took a prominent part in obtaining the agricultural statistics of 1866-67, the collection of which for many years constituted a most important part of the work of the Statistical Department of the Board of Trade, the cattle plague having led to a demand for exact information about the flocks, herds, and crops of the country. Shortly before his retirement he visited South Africa at the request of the Cape Government, to advise as to their system of keeping statistics.

From 1864 to 1867 he held a commission as Lieutenant in the 2nd Royal Surrey Militia, which he resigned in the latter year.

Since his retirement from the Board of Trade he resided at Berkhamsted in Hertfordshire, where he took an active interest in local affairs, becoming a Magistrate of the County, a County Councillor, and one of the Churchwardens of the Parish; while as County Councillor he was one of the local Elementary School Managers. He was at the same time a member of the County Education Committee, and one of the Governors of Berkhamsted School. He was also a keen Freemason, and was for many years President of the local Cricket Club.

Latterly he suffered greatly from failing health, which compelled him to curtail the part which he took in local affairs, and he died on May 10, 1906.

He was elected a Fellow of the Society on April 17, 1895, and in the interest which he took in meteorology he had the advantage of the example and sympathy of his near neighbour and warm friend Mr. Edward Mawley.

William Peregrine Propert, who died on October 3, 1906, at the age of 74, was a Doctor of Music and LL.D. of Oxford. At the suggestion of Mr. E. P. Phillips, of Haverfordwest, he took up the subject of meteorology in 1879, and carried on a valuable series of observations at St. David's, Pembrokeshire, until 1902, when he was compelled by failing health to discontinue what was to him a labour of love. His musical abilities were of a high order. He was for many years examiner in Arts to the Worshipful Society of Apothecaries.

He was elected a Fellow of this Society on February 18, 1880.

Col. Francis Richard Waldo Sibthorp was the son of the late Colonel Charles De L. Waldo Sibthorp, who for several years represented Lincoln City in Parliament. He had a distinguished, if short, army career. He was a veteran of the Crimea, and had also seen active Indian service in the Punjab Campaign with the 60th Rifles. It was with the 97th Regiment, however, that he took part in the Crimean War. As a young company captain he took part in the storming of the Redan, and commanded one of the first ladder parties in that desperate assault. He was severely wounded, and was invalided home, and his wound proving very troublesome, he soon after retired from the service with the rank of lieutenant-colonel, receiving, among other rewards for his gallant services, the Order of the Legion of Honour, which he was destined to live to wear for half a century. He died on April 16, 1906, in his 88th year.

He was elected a Fellow of this Society on December 19, 1900.

William Sowerby was the son of James De Carle Sowerby, and was born in 1827. About the year 1844 he became assistant to his father, the first Secretary to the Royal Botanic Society, Regent's Park, whom he succeeded about 1869. He retired from this post in 1895, and was succeeded by his son, Mr. J. B. Sowerby, the present Secretary.

He took a great interest in meteorology and became a Fellow of this Society on June 17, 1863, and was a member of the Council in 1875-7.

He died on March 9, 1906.

APPENDIX IV.

PURCHASES DURING THE YEAR 1906.

1. Books.

Glazebrook, R. T., and Shaw, W. N.—Practical Physics. 4 ed. Revised. 8°. London, 1903.

International Catalogue of Scientific Literature. Fourth Annual Issue, C. Physics. F. Meteorology. 8°. London, 1906.

Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 1905-1906. 8°. London, 1906.

2. Lantern Slides.

Thunderstorm Map, July 8, 1893 (4 slides). Meteorological Station West Norwood (2 slides). Fog at Weymouth, July 19, 1906 (2 slides). Rainfall Maps (3 slides). Snow Crystals, W. A. Bentley (2 slides). Windmill. Mean Max. and Min. Temperature. L. B. and S. C. R. Poster, Sunny Winter Resorts. Greenwich, June to Sept. 1906, Bar. Temp. Rain, Sun. Isobars, June to Sept. 1906. Rainfall, June to Sept. 1906. Sunshine, June to Sept. 1906. Isotherms of Max. Temp., Aug. 30 to Sept. 3, 1906 (6 slides). Daily Sunshine, Aug. 31 to Sept. 3, 1906. Weather Charts, Aug. 30 to Sept. 3, 1906. Weekly Death Rate and Mean Max. Temp. Punch's Farewell to Summer.

APPENDIX V.

DONATIONS RECEIVED DURING THE YEAR 1906.

1. Books and Pamphlets.

Presented by Societies, Institutions, etc.

Aachen, Meteorologische Observatorium.—Deutsches Meteorologisches Jahrbuch, Aachen, 1904.

Acireale, R. Accademia di Scienze Lettere ed Arti.—Rendiconti e Memoire, serie 3a., 3, 1904-5.

Adelaide, Observatory.—Meteorological observations at Adelaide Observatory and other places in South Australia and the Northern Territory, 1902-4.

Antwerp, Expédition Antarctique Belge.—Resultats du Voyage du S.Y. *Belgica* en 1897-98-99. Rapports scientifiques.

Athens, Observatoire National.—Annales, **4**.

Bangalore, Central Observatory.—Meteorology in Mysore, 1905.—Report on the Rainfall Registration in Mysore, 1905.

Barbados, Colonial Secretary's Office.—Returns of Rainfall in Barbados, 1906.

Barcelona, Observatoire de L'Ebre.—Notice sur l'Observatoire et sur quelques observations de l'éclipse du 30 Août, 1905.

Batavia, Magnetical and Meteorological Observatory.—Observations, 1903-4.—Rainfall in the East Indian Archipelago, 1904.

Belgrade, Observatoire Central.—Bulletin Mensuel, **1** and **2**.

Berlin, Deutsche meteorologische Gesellschaft.—Meteorologische Zeitschrift, Dec. 1905 to Oct. 1906.

Berlin, Gesellschaft für Erdkunde.—Zeitschrift, 1905, No. 10, to 1906, No. 9.

Berlin, Königlich-Preussisches meteorologisches Institut.—Bericht über die Tätigkeit, 1905.—Die Niederschläge in den Norddeutschen Stromgebeiten, von Dr. G. Hellmann. Deutsches Meteorologisches Jahrbuch, 1904-5, Preussen und benachbarte Staaten.—Ergebnisse der Beobachtungen an den Stationen II. und III. Ordnung, 1900.—Ergebnisse der Magnetischen Beobachtungen in Potsdam, 1901.—Ergebnisse der Meteorologischen Beobachtungen in Potsdam, 1902. Ergebnisse der Niederschlags-Beobachtungen, 1902.

Bidston, Liverpool Observatory.—Report of the Director, 1905.

Birmingham and Midland Institute.—Records of Meteorological Observations taken at the Observatory, Edgbaston, 1905.

Bognor, Climatological Society.—Report, 1905.

Bologna, Osservatorio della R. Universita.—Osservasioni meteorologiche dell' annala 1904.—Tavole calcolare il nascere e tramontare della Luna a Bologna.

Bremen, Meteorologische Station.—Deutsches Meteorologisches Jahrbuch, 1905. Freie Hansestadt Bremen.

Brighton and Hove Natural History Society.—Annual Report for the Year ending June 1905.

Bordeaux, Société d'Oceanographie.—Rapports presentés à l'Assemblée générale de Janvier 1906.—L'erosion marine à la Pointe de la Coubre.

Brussels, Académie Royale de Belgique.—Annuaire, 1906.—Bulletin de la classe des Sciences, 1905, No. 9, to 1906, No. 8.

Brussels, Observatoire Royale de Belgique.—Annales **5** and **16**.—Annales, Nouvelle Série, Physique de Globe, **3**.—Annuaire météorologique, 1901-6.—Observations météorologiques à Uccle, 1900-1902.

Bucharest, Institut Météorologique de Roumanie.—Analele, 1901.

Budapest, K. ung. Reichsanstalt für Meteorologie und Erdmagnetismus.—Bericht über die Thätigkeit, 1903.—Jahrbuch 1902, Theil 4; 1903, Theil 1 and 3; 3^{tes} Verzeichniss für die Bibliothek im Jahre 1903.

Buitenzorg, Institut Botanique de l'État.—Observations météorologiques, 1903-4.

Cairo, Société Khédiviale de Géographie.—Bulletin, **6**, No. 9.

Cairo, Survey Department, Public Works Department.—Meteorological Observations made at various places in Egypt, Sept. to Nov. 1905.—Meteorological Report, 1903.—The Rains of the Nile Basin in 1905, by Capt. H. G. Lyons.

Calcutta, Meteorological Office.—Climatological Atlas of India.—Copies of the Memoranda on the Monsoon, submitted to Government in April, May, June, Aug., and Sept. 1905, and a comparison of the forecasts with the actual rainfall.—Indian Daily Weather Charts, Dec. 1, 1905, to Nov. 30, 1906.—Indian Monthly Weather Review, May 1905 to April 1906.—Indian Meteorological Memoirs, **20**, part 1.—Memorandum on the Meteorological conditions prevailing in the Indian Monsoon Region before the advance of the South-west Monsoon of 1906, with an estimate of the probable Distribution of the Monsoon Rainfall, 1906.—Memorandum on the Meteorological conditions prevailing in the Indian Monsoon Region during the first half of the South-west Monsoon Period of 1906 with anticipations regarding the Monsoon Rainfall during Aug. and Sept. 1906.—Memorandum on the Meteorology of India during Oct. and Nov. 1906, with a forecast of the Rainfall in Northern India and of the Snowfall on the neighbouring mountain areas during the cold weather of 1906-7.—Rainfall of India, 1904-5.—Report on the Administration, 1905-6.

Cambridge, Mass., Harvard College Observatory.—Observations and Investigations made at the Blue Hill Meteorological Observatory, 1903-4.—Peruvian Meteorology.

Cape Town, Meteorological Commission.—Report, 1904, and for the year ending June 30, 1905.

Cape Town, South African Philosophical Society.—Transactions, 16, part 3.

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Wallen, A.—Régime hydrologique du Dalelf.

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Zenger, C. V.—La période luni-solaire et le temps qu'il fera pendant l'eclipse du 30 août, 1905.—La théorie electrodynamique du monde et le radium.—La théorie electrodynamique du monde et les éruptions volcaniques et grands sesmes.

2. Photographs.

Gegg, F.—The Record Flood, Evesham, 1901 (2).

Morgan, J. R.—Lightning.

Roberts, G. B.—Lightning.

Simmons, A. A.—Lightning (2).

Wilkie, H.—Lightning (2).

3. LANTERN SLIDES.

MAWLEY, E.—Phenological Observations (14).
NEGRETTI & ZAMBRA (Messrs.).—Kew pattern Magnetometer.
ROBERTSON, W.—Lightning (3).

4. APPARATUS.

GRAY, (Messrs.) J. W., & SON.—Exhibition Case of Specimens of Rod, Tape, Accessories, etc., for Lightning Conductors.

Ice and its Movements in Baffin Bay.

A very thorough study of the movements of the ice in the region of Baffin Bay, as a result of currents and weather influences, forms part 7 of the *Veröffentlichungen* of the Institut für Meereskunde and the Geographical Institute of Berlin University. Its author is Dr. Ludwig Hecking, who, after a general discussion of the relative influence of currents and wind on drift-ice, deals in full detail with the effects of both agencies in the area in question. From theoretic considerations, supported also by actual instances, he concludes that while pack-ice is influenced in its movements by any wind that is blowing at the time, and while icebergs are of course moved by the wind when currents are practically absent, the wind has but a minor effect in the case of bergs where definite currents exist. In tracing in detail the effects of currents in the Baffin Bay area, the writer has naturally to examine minutely the whole régime of the circulation, and this section is perhaps the most important part of the memoir, as some of the conclusions arrived at differ from those of previous writers like Pettersson. In particular he holds that the so-called *North water*, south of the entrance to Smith Sound, which is remarkable from its comparative freedom from ice even in winter, is really Atlantic water, which enters Davis Strait as an under-current, and comes to the surface in the far north. Others have considered it to be derived from the relatively warm, northward-flowing West Greenland current; but besides adducing evidence to show that the Davis under-current is maintained for a long distance through Baffin Bay, Dr. Hecking contends that, as there seems little doubt that a movement of cold water takes place southward in the vicinity of Cape York, it would be impossible for the warmer water of the West Greenland current to make its way across this to the position of the North water. Another important point is that of the existence and source of the "middle ice current" running southward from Melville Bay, which Dr. Hecking considers to receive an impulse from three more primary currents (including the Davis under-current), besides that which results from the melting of ice in the bay. In summarising the general system of circulation, he shows that all the various components combine to feed the great Labrador current, which maintains its unity until outside the limits of the area dealt with. The question of the effects of weather conditions is more complicated, and must be referred to briefly only. Besides causing minor variations in the conditions of ice-drift, weather plays an important part in determining the amount of ice present from year to year in the sea off Newfoundland. Dr. Hecking points out that it is necessary to deal separately with the sea-ice and glacier-ice. He finds that the amount of the former varies directly with the steepness of the pressure-gradient, during the months November to January, between South Greenland and the mouth of the St. Lawrence. The amount of glacier-ice depends on more complex causes, the weather of the preceding *summer* exercising, however, a predominant influence. In conclusion, the writer points out the need of research to elucidate (1) the question of periodic variations in the amount of ice; (2) the relation between years of abundant ice in the Iceland and Newfoundland waters respectively.—*Geographical Journal*, October 1906.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

March 20, 1907.

Ordinary Meeting.

Dr. HUGH ROBERT MILL, President, in the Chair.

Major BADEN F. S. BADEN-POWELL, 32 Princes Gate, S.W.;
DOMINGOS BEBIANNO, 189 Rua Sao Christovao, Rio de Janeiro;
REGINALD THOMAS G. CROSS, Khoreel Estate, Daloo, India;
BENJAMIN JAMES DONNELLAN, Zuurbekon, Johannesburg;
GEORGE A. GREEN, P.W.D., Poona, India;
HENRY WILLIAM HIPWELL, F.R.G.S., 3 Allison Grove, Dulwich, S.E.;
Major J. BRUCE KINGSMILL, Compton Mount, Winchester;
ERNEST LAWSON MANSERGH, M.Inst.C.E., Elm Lea, Woking;
WALTER LEAHY MANSERGH, Assoc.M.Inst.C.E., Hampstead, N.W.; and
Pandit G. M. VIDYABHUSAN, Gauhati, Assam, India,
were balloted for and elected Fellows of the Society.

THE PRESIDENT (Dr. H. R. MILL) said that before calling upon the Lecturer he would direct the attention of the Meeting to a few exhibits which had been very kindly lent for the occasion. The Lecturer himself had brought certain models to which he would presently refer. The Society showed a Dines' kite and meteorograph, which were suspended from the ceiling. Mr. W. H. Dines lent one of his meteorographs; Messrs. Negretti and Zambra, a statoscope, a meteorograph, a barograph for use in balloons, and a balloon compass; Mr. J. J. Hicks, a Dines' meteorograph and an aneroid for use in balloons; and Messrs. J. Levi and Co., the representatives of Messrs. Richard of Paris, a meteorograph and two barographs for use in balloons.

It was gratifying to find such a large number of candidates for the Fellowship of the Society, including, he was glad to say, the Lecturer of the evening; the accession of new Fellows was necessary to the continuance of the Society, on account of the mortality which was always thinning the ranks. They had recently to deplore the death of their distinguished Honorary Member, Dr. W. von Bezold, of Berlin, and on this occasion they had also to record the loss of Mr. H. C. Russell, F.R.S., the Government Astronomer and Meteorologist at Sydney.

The work of the Society was, he hoped, not altogether dull, nor was it always abstrusely scientific; it should never be dull, however scientific its discussions were, but the Meeting for which they were gathered together on that occasion was of a special kind, intended to attract as well as to instruct. There were other meetings of a more distinctly social character, and he wished to call attention to the Annual Dinner of the Society, which was fixed for June 18. He also mentioned that the Council, who had hitherto been in the habit of dining together before the ordinary evening Meetings, had decided to open the door to other Fellows of the Society, and with this object "THE METEOROLOGICAL CLUB" had been instituted that day. New candidates for membership, who must be Fellows of the Society, would be proposed by existing members of the Club. It was hoped the Fellows of the Society would thus be drawn together by fresh ties of acquaintance and community of interest. In this way he hoped the Club would serve a useful purpose.

They were that evening continuing a series of Lectures which was initiated many years ago, and which, as a rule, alternated with Exhibitions of objects of meteorological interest. They could not forget that the science of the weather and the wider science of the atmosphere touched a great diversity of interests. During the last few years special attention had been directed to the study of the free atmosphere at heights far above the ground. Previously the study of Meteorology was scarcely concerned with anything but the phenomena at the earth's surface, and meteorologists only felt competent to deal with those layers of the air immediately around them. They were now beginning to rise in the air, if not in the world, and were looking eagerly at regions of the atmosphere which formerly lay entirely beyond their reach. Efforts had been made by the Royal Meteorological Society to encourage the renewal of research by means of kites and balloons; and Mr. Dines, who had done so much in this way, had on more than one occasion described his work to them. That evening they were to have the pleasure of hearing a lecture from one of the pioneers in the use of kites, and some of the lantern slides which the Lecturer would show would be something of a revelation to most of them. He (the President) had prolonged his introductory remarks, but not unduly, as he did not wish to call upon the Lecturer until the balloting-papers had been examined. He had now the pleasure of calling upon the "youngest Fellow," Major B. Baden-Powell, to deliver a lecture on "The Exploration of the Air."

Major B. F. S. BADEN-POWELL then delivered a Lecture on "THE EXPLORATION OF THE AIR" (p. 193).

THE PRESIDENT, at the conclusion of the Lecture, said that they had suppressed the time-honoured method of proposing and seconding a vote of thanks, which had almost become an antiquated custom, because modern audiences made it clearly apparent whether they had enjoyed a lecture or not. On this occasion there was no uncertain sound. He found that generally the smaller the vote the larger the thanks; and the less time taken by the remarks of other people, the more was the lecturer honoured, and the better pleased every one was. He could not let the occasion pass, however, without expressing their gratitude to Major Baden-Powell for his fascinating lecture, but he might mention one point upon which the opinion of the audience and the lecturer differed entirely. That arose when the lecturer said he had said enough about the subject. The lecture was so interesting that he had hardly realised how much ground the lecturer had gone over; and when even a chairman, usually the least interested person at a meeting, found a lecture too short, it said a great deal for the lecturer. When he (the President) took the photograph which had been shown of Major Baden-Powell raised by a train of kites above the trees, he had not had much expectation of ever seeing him on earth again; but the inventor of man-lifting kites alighted as safely as he had risen. Major Baden-Powell had explained to them some wonderful advances in the direction of making the air a pathway. He hoped that ultimately the younger and more venturous meteorologists would pursue the new routes in flying machines, and investigate, it might be, the origin of rain in the higher clouds themselves. He knew that there were persons in the Society who would like to undertake such work, but he would beg of them not to reduce the number of Fellows of the Society by premature flights, but rather to wait until the members of the Aeronautical Society and the Aero Club had shown the way to become expert aviators. He thanked Major Baden-Powell in the name of the Meeting for his kindness in coming there that evening, and for the very interesting manner in which he had developed the subject.

April 17, 1907.

Ordinary Meeting.

Dr. HUGH ROBERT MILL, President, in the Chair.

CHARLES A. O. BUYZER, 128 Hultsdorf Street, Colombo, Ceylon ;
DOUGLAS W. FRESHFIELD, F.R.G.S., 1 Airlie Gardens, W. ;
JAMES EDWARD HORNSBY HILL, B.Sc., 41 The Avenue, Leigh, Lancs ;
WILFRID CHARLES LANE, 23 The Avenue, Leigh, Lancs. ;
Capt. COLMER WILLIAM DONALD LYNCH, 1 St. James's Square, S.W. ;
Capt. STANLEY C. PEACOCK, Damietta, Egypt ;
S. M. SHAFI, Sports Bungalow, Ennur, Madras, India ;
JOSEPH TURNER, 4 Hopewell Terrace, Matlock ;
THOMAS TYRWHITT, P.W.D., Pretoria, Transvaal ; and
PHILIP DAVID WARREN, A.I.C.E., F.R.G.S., Colombo, Ceylon,
were balloted for and elected Fellows of the Society.

The following communications were read :—

1. "PHENOMENAL RAINFALL IN SUVA, FIJI, AUGUST 8, 1906." By ROBERT L. HOLMES, F.R.Met.Soc. (p. 201).

2. "TEMPERATURE AROUND THE BRITISH ISLANDS IN RELATION TO THE GULF STREAM." By RICHARD STRACHAN, F.R.Met.Soc. (p. 207).

3. "WEATHER REGARDED AS A FUNCTION OF CLIMATE." By L. C. W. BONACINA, F.R.Met.Soc. (p 213).

CORRESPONDENCE AND NOTES.

Investigation of the Upper Atmosphere.

The International Commission of Scientific Aerostation at its last meeting at Milan, resolved, on the recommendation of M. Teisserenc de Bort, to carry on during the years 1907 and 1908 the investigation of the upper atmosphere in the Northern hemisphere on a much more extended scale than has hitherto been attempted.

The Royal Meteorological Society has been invited to take part in this scheme. The matter has been placed in the hands of the Kite Committee, who are desirous of securing the co-operation of observers in different parts of the British Empire north of the Equator, and they propose, if possible, to organise and equip special stations for this purpose.

In connection with the investigation, balloons (*ballons-sondes*) to carry self-recording instruments, and also smaller balloons, are to be used, the heights and drift of which will be determined by two theodolites placed at the ends of a fixed base. The special ascents in 1907 are to be made on July 22-27, September 4-6, and November 6-8, one balloon to be sent up on each of these days.

The expenses connected with the supply of instruments and of balloons will be considerable—especially as the balloons are not again serviceable after an ascent.

In view of the importance of the proposed investigation and the desirability of British co-operation on an adequate scale, the Council invite contributions from Fellows towards the cost of carrying out this great international research, and they also desire the co-operation of observers who may be willing to take an active part personally in the work.

Trees and Lightning.

MR. W. R. FISHER in his recently published book on *Forest Protection* gives some particulars about the liability of trees to be struck by lightning. As very little reliable information is available on the subject, the following extract from Mr. Fisher's book will be of interest:—

All species of trees are liable to be struck by lightning, but oaks and other species with deep roots appear to be most exposed to this danger, perhaps on account of their roots forming better conductors to the moist subsoil than those of shallow-rooted species.

According to the valuable observations made annually by Dr. Hess from 1874 to 1890 in the forests of Lippe-Detmold, among broad-leaved trees the oak suffers most, among conifers the Scots pine. Then follow spruce and beech. The birch, poplars, ash, alder, willows, larch, and other trees suffer only exceptionally.

TREES STRUCK IN LIPPE-DETMOLD, 1874-1890.

Broad-leaved trees.		Conifers.	
Oaks	310	Scots pine	108
Beech	33	Spruce	39
Birch	10	Larch	11
Poplars	6	Austrian pine	1
Ash	4	Weymouth pine	1
Willows	2	Others	5
Other trees	8		
Total	373	Total	165

The forest was stocked as follows:—

	Per cent.
Oak	11
Beech	70
Spruce	13
Scots pine	6
	100

The danger, therefore, considering the beech as 1, was 6 for a spruce, 37 for a Scots pine, and 60 for an oak.

Other observations by Collodon, Hellmann, Cohn, and Caspary give somewhat different results.

Thus Hellmann, considering danger for the beech from lightning as 1, gives—

Conifers	15
Oaks	54
Other broad-leaved trees	40

Cohn gives—

Oaks	14	out of 40 trees struck.
Poplars	12	

Caspary gives—

Oaks	15	out of 93 trees struck.
Poplars	34	

C. Hess (1896) found that pyramidal poplar is often struck, and that in eight out of the ten cases he observed lightning passed from the tree to a neighbouring building. Poplars should, therefore, not be too near to buildings.

According to Collodon, near the lake of Geneva, poplars rarely suffer from lightning.

In the *Revue des Eaux et Forêts*, the results are given of fifteen years' experience in a forest composed as follows :—

	Oak.	Beech.	Spruce.	Pine.	Others.
Percentage of trees . . .	11	70	13	6	...
Trees struck by lightning .	159	21	20	59	20
Relative frequency . . .	48	1	5	33	...

This agrees generally with the results obtained in Detmold.

Similar observations were made in the Bavarian State Forests, 1887-1890:—

Trees struck.		Percentage of area occupied by each species.
Scots pine	131	30·8
Spruce	88	41·50
Silver fir	67	
Oaks	61	1·82
Soft woods (broad-leaved) . . .	11	2·41
Larch	7	0·58
Beech	7	10·79
Total . . .	372	87·90

In the Saxon State Forests, in 1897, the first year that such observations were made, it was found that the danger for oak was six times that for conifers.

On the whole, from these observations, it is evident that local circumstances, such as proximity of lakes, dampness of soil, density of growth, healthy or unhealthy condition of trees, affect the question whether one species will be more liable to attack than another in any particular locality.

Some experiments as regards the conductivity of electricity by wood have been recently made by Jonesco, of the Württemberg Society of Natural Science. In these experiments Holz's electric machine was used.

1 turn passed the spark through oakwood,
12 to 20 turns through beech,
5 turns through poplars and willows.

The use of heartwood or sapwood and state of dryness of the wood made no difference in the results, but the richness of beech in oil prevents its being a good conductor.

Fischer (*Biologie der Holz Gewächse*) distinguishes between oily trees and starchy trees. In oily trees the elaborated starch during winter and spring becomes converted into oil and passes into the pith, wood, and bark. Part of the starch in the bark also becomes converted into glucose. In the starchy trees the reserve starch remains unaltered between autumn and May.

The green wood of the oily trees (beech, walnut, birch, lime), especially wood very rich in oil, is a bad conductor of electricity. The starchy trees (oak, poplar, maples, ash, elm, *Sorbus*) are good conductors. Conifers are intermediate, the Scots pine in summer being as poor in oil as the starch trees, but rich in oil during winter. After the oil had been extracted from wood of fatty trees by means of ether they became as good conductors as typical starchy trees.

Starchy trees are therefore more in danger from lightning than oily trees.

Damp soils conduct electricity well, but in dry places when the lightning has reached the ground, it may spread from root to root of neighbouring trees and cause them to die in groups.

It is probable that when sound, well-conducting trees growing on damp soil are struck, the lightning passes rapidly down to the earth without causing much breakage ; but that when rotten wood is met with, which is a bad conductor, the crown or branches may be broken, or even the tree set on fire.

The relative frequency with which trees are struck on different soils in Lippe-Detmold is given below:—

Loam	220	Keuper marl	35
Sand	118	Calcareous soil	23
Clay	84	Flooded land	4

This may explain the greater danger to trees from lightning in North Germany as compared with South Germany and Austria. It is also possible that loam and sand, producing most oaks and Scots pine, have high figures, while on calcareous soil, the beech predominates.

Trees are said to be more frequently struck by lightning in badly wooded plains than in well-wooded mountain districts. This is true of the bare middle Rhine valley and its adjoining wood-stocked hills.

It is supposed that dense forests act as conductors, and allow electricity to pass gradually from the earth to the clouds, whilst clearing the land of forests increases the heat of summer and hinders the neutralisation of the electricity of the clouds.

Lightning, according to Hess, strikes in preference trees standing free from their neighbours, those in avenues and on the border of a wood, and also trees dominating over the rest of a wood.

Sound trees are more frequently injured than unsound trees, but dry trees may be struck, and stag-headed oaks are frequently smashed to pieces by lightning. Thus a positively electrified cloud induces the separation of the electricity in a tree, driving the positive electricity into its roots and the earth, whilst the tree becomes charged with negative electricity. The strength of this charge becomes weakened by gradual discharges into the atmosphere from the numerous twigs and leaves in the crown of a vigorous tree. On the contrary, a tree with many dry branches and scanty foliage becomes thoroughly charged with negative electricity, and when struck by lightning receives a more violent shock than a sound tree.

Climate of Egypt.

The following interesting sketch of the normal climate of Egypt and the Sudan is given in Part II. of the *Meteorological Report for the Year* 1904 of the Survey Department, Egypt:—

Climatologically, the country served by the meteorological stations of the Department may be subdivided into four regions:—

1. The North Coast and the Delta.
2. Middle Egypt down to latitude 27° N.
3. Upper Egypt and the Northern Sudan as far south as latitude 18° N.
4. The rest of the Sudan to latitude 5° N. The Red Sea littoral and the country south of latitude 10° form two subdivisions.

The first region depends for its climate on proximity to the Mediterranean, and is much affected by the storms of that sea. The prevailing wind is the North-east Trade, which here blows rather from the North-west. Storms passing to the north bring South winds, followed by comparatively abundant rain in winter and spring.

The second region forms a transition belt between the first and third. It is near enough the Mediterranean to feel the influence of the prevailing weather there, but is chiefly influenced by the presence of the desert on both sides.

The third region is beyond the influence of the Mediterranean weather, and is entirely controlled by its proximity to the desert. The North-east Trade blows uniformly all the year, and South winds are almost unknown. Rain is limited to occasional falls in thunderstorms.

The fourth region is affected in summer by the monsoon of North-east

Africa, but for the rest of the year lies in the belt of the North-east Trades. It thus suffers a regular seasonal alteration of weather, dry Northerly winds prevailing for rather more than half the year, while moist Southerly winds, accompanied by copious rain, blow for the remaining portion.

Pressure.—The distribution of pressure in Egypt and the Sudan is simple and of great stability. During the winter the Atlantic anticyclone extends across the Sahara, and the Siberian anticyclone reaches southwards towards the Persian Gulf, while the col between the two high pressure areas is divided by a third but relatively much lower high pressure over Arabia into two, on the side of one of which Egypt is situated. Pressure is then low over the Mediterranean, and from time to time cyclonic areas pass eastward bringing storms and rain to the first district. In the Sudan a valley of low pressure extends northwards from the Equatorial minimum.

In spring pressure gradually gives way all over the two countries, and the monsoon depression begins to form to the north of the Arabian Gulf, while the axis of the Sudan valley of low pressure swings round towards the east.

By June the monsoon depression has developed and the Sudan lies under the influence of a V-shaped offshoot from the Indian monsoon area, whose axis points north-eastwards. In summer the distribution, then, shows the permanent anticyclone to the west, with the minimum pressure near the Persian Gulf, so that Egypt lies on the slope of almost straight isobars between the two. The Sudan, on the east, lies within the monsoon area, while the south-west probably comes under the influence of a similar but less marked low pressure lying over the Congo basin.

The Central Sudan is thus in a col. The isobars are most closely packed in August, but by September pressure to the east has begun to rise again, and in October the high pressure area over Arabia reasserts itself, so that winter conditions then commence, and continue till they culminate in January. Pressure is thus high—from 29·9-30·3 ins.—all over the two countries in winter; or falls to from 29·72 ins. and 29·85 ins. in Egypt as the monsoon develops, reaching these minimum values in July, when it commences to rise again.

Temperature.—Temperature in general throughout the year is highest towards the south, but there are two exceptions to the general rule. In winter, proximity to the Mediterranean causes the northern sea-board to have a higher temperature than Middle Egypt, but the effect disappears rapidly as the coast is left. Again, before the commencement of the Kharif or rainy season, the highest temperature is found in the Middle Sudan, since the southern part is cooled by the more luxuriant vegetation as the Equator is neared.

The different regions vary considerably as regards both average temperature and range. Thus under the moderating influence of the sea, the first region enjoys a comparatively equable temperature and suffers less from extremes than the drier parts to the south in Middle and Upper Egypt. The thermometer very rarely falls to the freezing point and seldom exceeds 95°. The daily range varies 13° to 18° during the year, and the mean annual range is about 36°.

The second district, on the other hand, from its dryness is subjected to the full power of the solar rays during the day, and to free radiation through a thermally transparent atmosphere during the night, with the consequence that the days even in winter are warm, while the nights are extremely cold. Thus the mean daily range varies from about 20° at Cairo in winter to about 36° at Nag Hamadi in summer, and the mean annual range varies from about 54° at Cairo to 58° at Assiut. Frost is not uncommon during the early morning hours in winter.

The third district much resembles the second, except that the winter minima are as a rule not so low, while the summer maxima are a few degrees higher.

The fourth district may for temperature comparisons be conveniently divided into three—the Red Sea littoral, the Middle Sudan, and the Upper Sudan, including the Bahr el Ghazal.

In the first the influence of the sea is again prominent, and the daily and annual ranges are smaller than obtain in the Middle Sudan. A curious phenomenon is that the maximum temperature is frequently found in the early part of the day, after which a sea breeze brings coolness.

In the Middle Sudan the winter climate is assimilated to that of the third principal region, modified by greater altitude and nearness to the Equator. The daily range is somewhat greater, but owing to the entire change of climatic conditions in summer, the full power of the sun's rays is not felt then, and consequently the mean annual range is rather less. For this reason the highest temperatures are met with in April or May, just before the South winds of the monsoon of north-east Africa set in.

In the third subdivision the effects of the moisture evaporated from the marshes and from the luxuriant savannahs become prominent, and both daily and annual ranges diminish rapidly, so that at Mongalla (lat. 5° 11′ N.) the former is only about 22° on the average, and the latter 32°. A striking feature is that the highest temperatures are recorded early in the year when the region is under the influence of the dry, Northerly winds from the deserts of the Middle Sudan.

Humidity.—As regards humidity, the region falls sharply into two divisions, comprising respectively the first three districts and the last. In the former the maximum relative humidity is everywhere found in winter with the minimum in summer, whereas in the Central and Southern Sudan the lowest relative humidity is found in April or May before the advance of the Kharif. The humidity then rises rapidly to a maximum corresponding with the height of the rainy season. Merowe, which lies near the border-line, frequently shows the double maximum in winter and summer, and the double minimum in spring and autumn. The Red Sea littoral in this respect belongs to the former region.

The absolute humidity, as measured by the vapour tension, reaches its maximum everywhere in July or August; but in the first three districts the minimum is found in February in the north and in January towards the south, while in the Sudan, south of Merowe, the minimum occurs in March or April. At Merowe itself there is frequently evidence of a second minimum corresponding to that of the country to the south.

The relative humidity is greater near the coasts and in the cultivated regions of the Delta and Lower Egypt, but falls rapidly as the hot third region is approached. From lat. 18° to 10° N. it remains more or less uniform in winter, but as the rainy season draws near, this part becomes damper. South of lat. 10° N. the humidity remains high—nearly equal to that on the north coasts—throughout the year.

Cloud.—Egypt and the Sudan present almost diametrically opposite characteristics as regards cloudiness, for, whereas the north of Egypt is almost cloudless for long periods in summer, but often, especially during the approach of a cyclonic storm, overcast during winter, in the Sudan the reverse is the case, and clear skies prevail except during the summer rainy season. In Upper Egypt and the North Sudan cloud is a rare phenomenon.

The normal type in Egypt is Cumulus, but in the early winter months enormous wreaths of wispy Cirrus are frequent, and the storms are often heralded by thin Cirrus veiling the sky. In the Sudan Cumulus is the most common type.

Wind.—In the first three districts the Trade-wind blows during most of the year. Owing to the persistence of the anticyclone to the west, however, its direction changes clockwise from the North to the South, so that over the Delta the prevalent direction is North-west, to become due North in middle Egypt, and North-east over the Northern Sudan, especially in winter. As has already been mentioned, this Northerly wind is frequently reversed in the first two districts when an area of low pressure passes along the Mediterranean. These storms generally originate to the west and pass well to the north of Egypt, but occasionally southwards to the west. Frequently on reaching the Levant they become almost stationary, when for days together the wind in Lower Egypt blows from the West. South of lat. 18° N. the South-west winds of the monsoon commence about May or June, and blow almost uninterruptedly till October. In the extreme south the region of equatorial calms is reached, and light airs undecided in direction are very prevalent.

Rain.—In the first district rain is comparatively frequent in winter on the coast, but it rapidly diminishes as the sea is left behind. It is almost invariably cyclonic in character, and falls when the trough of the storm has passed, so that it is accompanied by Westerly or North-easterly wind, and it is almost entirely confined to the winter months. In the second district rain is more rare, and is usually due to a southward extension of the cyclonic conditions. In the third district rain is almost unknown, and is confined to occasional thunderstorms and to that which falls on the Red Sea hills during the winter. This is due probably to the passage of the humid North-west wind over these hills, and is therefore orographical in character. On the Red Sea littoral in the fourth district, the principal rains occur in winter, but occasionally the monsoon summer rains reach as far north as Suakim.

In the Sudan the winter is almost rainless, but heavy precipitation occurs during the prevalence of the Kharif. It is here due to the moist South-west wind being forced over the Abyssinian plateau, and is therefore orographical in character. In the north the rainy season presents a single maximum, but in the far south two maxima, corresponding to the two periods of a zenithal sun at noon, are to be found.

Special Phenomena.—In Lower Egypt thunder is rare, but is occasionally heard about the time of the equinoxes. In Upper Egypt and North Sudan it is also a rare phenomenon, but further south during the monsoon it is of almost daily occurrence.

Fog is frequently formed in autumn, winter, and spring, usually in the region of straight isobars lying between the anticyclone over Middle Egypt and a depression to the north-west. It is of almost daily occurrence in winter on the plateau bordering the Red Sea, and is frequently encountered in the basins of the Bahr el Jebel and Lower Sobat.

Dew is of regular occurrence in Egypt in autumn and winter when the amount of moisture in the air is high and the temperature is falling rapidly, and hoar-frost is sometimes met with in winter.

Ice occasionally forms in winter on shallow pools, but snow is almost unknown in the country. Sleet has been noticed as far south as Cairo.

Lunar and solar haloes are common, and as in Europe invariably herald an approaching depression.

As has been remarked, cyclonic storms in the Mediterranean are of comparatively frequent occurrence except in summer. In spring they give rise to the well-known Khamsins or hot, dusty, Southerly winds, but since their paths generally pass to the north, their effects are seldom felt beyond the second district. Regular cyclonic storms appear to be almost unknown in Upper Egypt or the Sudan. There is, however, in the latter country a phenomenon of much interest in the "habub," a dust-storm of considerable extent, but of short duration, seldom lasting more than a few hours.

Hoar Frost at High Altitudes.

The meteorological observatory on the Hohen Sonnblick, in the Tauern, publishes, in the fourteenth annual report of the Sonnblickverein for 1905, hoar-frost observations for the last three years. The following statements included among them are of general interest. By hoar-frost is understood spear and feather-shaped forms of ice, often several inches or even many feet long, arising on the wind side of objects exposed to the wind, through the freezing of drops of mist perceptibly underchilled, but yet fluid. This phenomenon occurs not seldom on the Sonnblick, but not in so pronounced a form as, *e.g.*, on the Brocken (3744 ft. high) or on Ben Nevis (4406 ft.), both of which rise to the average level of the winter clouds. The Sonnblick (10,180 ft.) shoots up into regions which in winter are deficient in moisture. On the Bjelašnica, in Bosnia (6782 ft.), on the other hand, by reason of its more southern situation and its proximity to the Adriatic, congelation is very strong. On February 20, 1902, the hoar-frost spikes on the observatory there attained within three days a length of 22 ft., and on the column of the sunshine recorder 9 ft.; this happened under a temperature of 27° F. during slight faint South winds, and with an average relative humidity of 93 per cent. On the Sonnblick the needles grow at most to lengths of a few decimetres. On the "Regina Margherita" observatory (15,180 ft.), on Monte Rosa, the highest meteorological observatory in Europe—which, however, unlike the "Zittelhaus" on the High Sonnblick, is not permanently inhabited—hoar-frost formation, to judge by the statements of Prof. Alessandri, likewise appear to be of frequent occurrence. On the Sonnblick there were in 1903 thirty-six days, in 1904 fifty days, and in 1905 thirty-nine days, with hoar-frost formation.—*Geographical Journal*, January 1907.

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THE BEST FORM OF RAIN GAUGE, WITH NOTES ON OTHER FORMS.

BY HUGH ROBERT MILL, D.SC., PRESIDENT,
Director of the British Rainfall Organisation.

[Read May 15, 1907.]

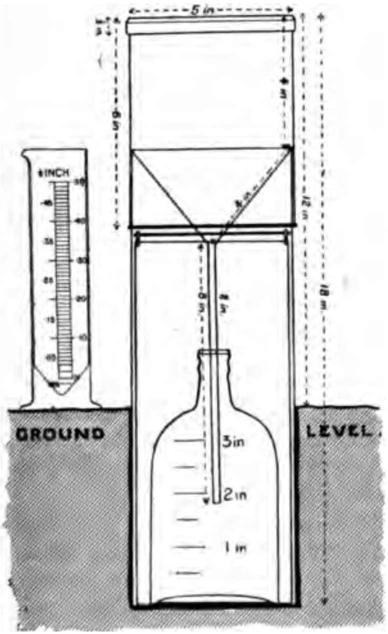
WHEN the late Mr. Symons founded the British Rainfall Organisation forty-seven years ago, such observations as were being carried on were made with rain gauges of the most varied patterns, set up at any height from the ground that suggested itself to the observer, and read irregularly at almost any hour of the day or night. Since that time there has been a steady approximation to uniformity; and now the rain gauges in use are, with few exceptions, of only two or three definite patterns, set for the most part at nearly the same height above the ground.

While the 5-inch Snowdon pattern rain gauge, introduced in 1864 and never materially changed, is deservedly the most popular form, there are still many 5-inch rain gauges without the vertical rim four inches deep above the slope of the funnel, including the Howard pattern so much in evidence at stores and horticultural shops, and the modified Howard known as the Symons pattern. The 8-inch Meteorological Office pattern of rain gauge is identical in design with the Snowdon, and is equally serviceable, differing only by its larger size. The 8-inch Glaisher rain gauge retains a considerable share of appreciation, especially amongst waterworks' engineers; and in Scotland the 3-inch Fleming float-gauge lingers in many places; and here and there throughout the country the still older 6-inch side-tube gauge is not yet extinct; while quite recently a small crop of the obsolete 10-inch square gauges has sprung up. Several observers who reported that they were using Snowdon rain gauges have been found, in fact, to have had something quite different; and I have been much struck in the course of my work by the disturbance to records caused by certain forms of rain gauges becoming worn or damaged. It therefore appears to be useful to put on record the specifications of the more trustworthy forms of rain gauge, and to utter a warning against the use of those forms which are either intrinsically defective, or which give misleading records when they fall into disrepair. Uniformity in rainfall measuring is so desirable that it is worth making an effort to secure it.

THE THREE BEST PATTERNS.

The Snowdon Rain Gauge I adopt as the standard for the British Rainfall Organisation, and although it is still capable of improvement—indeed several makers have recently introduced minor improvements—I believe that it is the best to be had. One advance would be to make the outer case of some thermal non-conductor, so as to diminish the slight risk of loss by evaporation and the greater risk of damage by freezing. For this purpose I have thought of having the outer cylinder cut out of a large bamboo, or made of wood pulp or *papier maché*, or even of two layers of thin metal with felt or plaster of Paris between, but I have not made any experiments on the subject.

The essential conditions which must be observed in any modern rain gauge are: (1) an accurately turned brass rim of correct diameter, and as sharp as is compatible with strength; (2), a vertical wall four inches high between the rim and the mouth of the funnel; and (3) the use of as small a number of separate pieces of metal as possible, and the avoidance of rivet holes or any openings in the casing. The dimensions and any variations not contravening the above conditions are of minor importance, but the following specifications may be found useful, and no harm would be done if they were generally adopted. The pitch of the funnel should incline towards steepness rather than towards flatness.



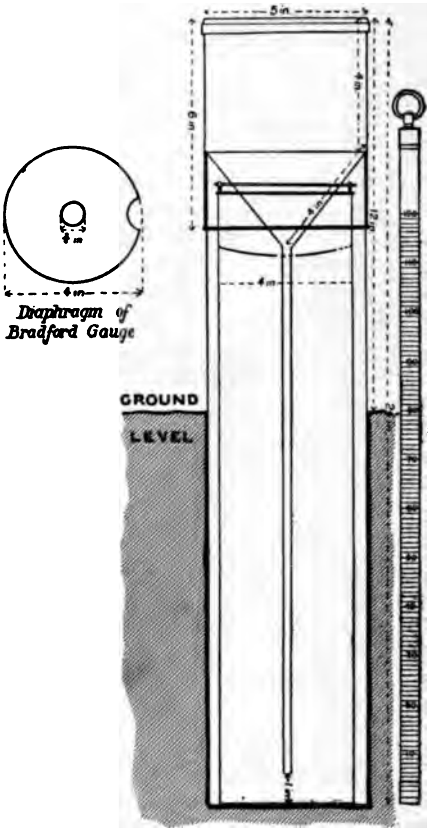
"SNOWDON."
FIG. 1.

The Snowdon gauge adapted for daily readings in any part of the British Isles may advantageously have the following dimensions:—Total height when closed, 1 ft. 6 ins.; diameter of opening, 5·00 ins.; depth of turned brass rim, ½ in.; depth of vertical rim to funnel 4 ins. continued, as one sheet of metal, 2 ins. farther so as to fit firmly over the mouth of the outer can. A ledge or shoulder on the outer can for the upper part to rest on is an advantage, though not necessary. Length of funnel along slope, 4 ins. opening into a tube not less than ¼ in. in internal diameter, and 8 ins. long. Total depth of outer can, 14 ins. Inner can fitting easily inside outer can with wire handle for withdrawing it. A bottle just fitting the inner can, and with a short narrow neck, should be provided, and it ought to be graduated roughly to show whole inches of rain.

The glass measure containing half an inch of rain should not exceed 1½ ins. in internal diameter, and the lower part should taper internally to a point so as to enable the critical quantity of ·005 in. to be very clearly defined. The divisions for each hundredth of an inch should be clearly etched on the glass, and the capacity up to each mark should be as follows in grains of water at 60° F. :—

TABLE I.—CAPACITY OF MEASURING GLASSES FOR RAIN GAUGES.

	For 5 in. gauge.	For 8 in. gauge.
Up to ·005 in.	25 grains.	63 grains.
,, ·01 ,,	50 ,,	127 ,,
,, ·02 ,,	99 ,,	254 ,,
,, ·03 ,,	149 ,,	381 ,,
,, ·04 ,,	198 ,,	508 ,,
,, ·05 ,,	248 ,,	635 ,,
,, ·10 ,,	496 ,,	1269 ,,
,, ·20 ,,	992 ,,	2539 ,,
,, ·30 ,,	1488 ,,	3808 ,,
,, ·40 ,,	1984 ,,	5078 ,,
,, ·50 ,,	2480 ,,	6347 ,,



Diaphragm of Bradford Gauge

"BRADFORD."

FIG. 2.

The Bradford Rain Gauge.—For monthly readings in wet localities, such as mountains or moorlands, the form of rain gauge recommended is the Bradford pattern designed by Sir Alexander Binnie. This is simply a Snowdon gauge of great capacity, made of proportionately stout material very strongly put together. The funnel is identical in dimensions with that of the Snowdon gauge, the tube being long enough to reach to within an inch of the bottom of the inner can. The inner can may be made long enough to contain from 12 to 30 ins. of rain, according to the nature of the site for which it is intended; but a total length of 2 feet is usually sufficient. The bottle is dispensed with. To check evaporation a slightly concave sheet of metal should be soldered 1½ in. below the mouth of the inner can with a hole ¾ in. in diameter in the centre, and a crescent-shaped opening at one side to facilitate pouring out the contents. To obviate any mistake in counting the number of glassfuls, which in a wet locality may be considerable, a graduated dip-rod of cedar, ½ in. wide and ¼ in. thick, tipped with brass, is dropped vertically into the inner can after the funnel has been removed. The rod when withdrawn shows the approximate amount of rain by the dark colour of the portion which was immersed, and the rain is then measured accurately by means of the glass, both readings being recorded. For the monthly readings the glass should have the capacity of an inch of rain or more, and it is sufficient to graduate it to tenths of an inch. The graduation of the dip-rod is effected by pouring an inch of rain measured in the glass into the inner can, inserting the rod, and on withdrawing it marking the line to which the water came, then repeating the operation until the inner can is full, and afterwards dividing each inch so determined into ten equal parts.

The Meteorological Office 8-*inch Rain Gauge* has the following dimensions:—Diameter of rim, 8·00 ins. Depth of vertical side above funnel 5½ ins., continued for 3 ins. to overlap the outer can. The length of the funnel along the slope is 5 ins., and the tube in which it terminates 10¼ in. long, the bore being about half an inch. The outer can should be 13 ins. deep, and may be provided with a shoulder for the lower edge of the upper part to rest upon. The inner vessel takes the form of a copper can, with a lip and handle from which the water can easily be poured. It is not usual to employ a bottle with this gauge, though in my opinion it would be useful to do so. The measuring jar for an 8-inch gauge should not be more than 2 ins. in diameter, should be conical

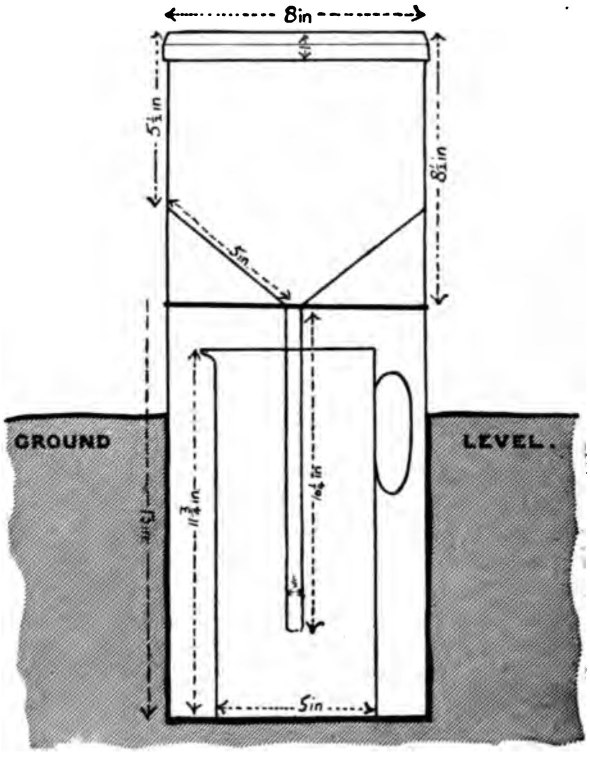


FIG. 3.—Meteorological Office 8-inch Rain Gauge.

below in order to allow the amount of ·005 in. to be clearly visible, and the graduations should be adjusted to the quantities of water shown in column 2 of Table I.

The deep-rimmed rain gauges specified above are the only forms which can be recommended, and any one of the three may be used with equal security. They are the only rain gauges to which the complete certificate of the British Rainfall Office "of approved construction" apply, and I am strongly of opinion that no scientific instrument maker ought to make or sell any other pattern of direct reading gauge unless under protest at the special order of a customer.

The life of copper rain gauges of these patterns when well made is practically unlimited; some after forty to fifty years' exposure remain unimpaired. Even zinc or galvanised iron gauges in moorland districts, far from the corroding elements of city smoke, have stood twenty years of service without a flaw being developed. This is due as much to simplicity of construction and the small number of parts as to strength of material.

The Howard rain gauge, which did splendid service in its day, and the Symons gauge, which, unfortunately, was named after Mr. Symons before he introduced the Snowdon pattern, ought not to be accepted by any purchaser, though they are, unfortunately, much pushed by the Stores and by nurserymen. Their shallow rim makes them useless in hail or snow, and uncertain on account of outsplashing in heavy rain, but they are unfortunately cheap. It seems to me that the retail price charged for the Snowdon pattern might reasonably be considerably reduced. If this were done a great many observers might be induced to discard their present unsatisfactory instruments in favour of new ones of approved form, and the makers would make more profit instead of less by such a concession.

When any of the forms referred to above becomes damaged, the tendency is to diminish the record of rain either by the distortion of the rim reducing the catchment area, or by leakage allowing water to escape. In rare cases water may leak in through holes in the side of the funnel, but damage of such a serious kind can always be readily detected.

OBSOLETE PATTERNS.

The original form of Glaisher gauge differed only slightly from the Meteorological Office pattern which developed from it; but at a later period it was modified, and the characteristic "tumble-home" of the funnel—if the nautical phrase may be permitted—was introduced. As now made it is an extremely ingenious instrument, and when new and carefully handled it gives results of unimpeachable accuracy. But when carelessly used, and especially when it begins to fall out of repair, it is subject to errors of so serious a kind that after carefully considering the matter in all its bearings I strongly recommend that the use of this gauge should be entirely discontinued in favour of one of the standard patterns. A source of slight error is the collar *d*, which is soldered to the outer can and is allowed to remain full of water, so as to

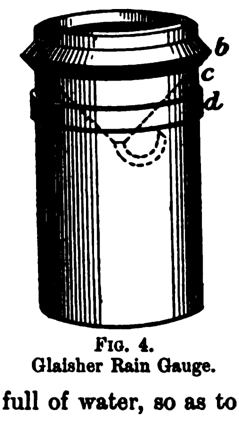


Fig. 4.
Glaisher Rain Gauge.

torm a "hydraulic joint" when the funnel is placed in position. When the funnel is put on quickly part of the water held in the groove is apt to be projected into the outer can, so that after a week of wet weather quite an appreciable quantity of water gathers which the observer is apt to collect and measure in the belief that it entered legitimately through the funnel. This defect can be remedied by perforating the collar. The short curved tube in which the funnel terminates is apt to get choked with dust, and when free it allows the water to fall into the inner can in small drops, and so promotes evaporation. This is now usually superseded by a long straight tube. The Glaisher gauge with these improvements gives a perfect record both of rain and snow, the comparison with a Snowdon gauge showing practically identical catches when the gauge is new and in good repair.

When the gauge begins to get old, the collar *d* is usually the first part on which the solder becomes loosened, allowing it to slip and so get lost. This in itself would not introduce much error, but it allows the rim of the outer can to strike into the angle between the copper ring *c* and the outside of the funnel to which it is soldered. The strain of opening and closing the gauge by pulling off and pressing on the upper part of the instrument—which must be grasped by the projecting part of the funnel—soon leads to a loosening of the soldered joint *c*, and very often the joint at *b* also begins to gape in places. The result is that when wind is blowing rain against the side of the gauge with the opening thus made a good deal of water may enter and run down the outside of the funnel into the inner can. If not repaired the next stage is for the band *c*, the soldering of which to the funnel at an acute angle must be a difficult matter, to drop altogether, and then the funnel rests on the rim of the outer can like an egg in an egg-cup, and rain runs freely down the outside of the funnel and is caught. The simile of an egg-cup is not exact, for when dissolution proceeds so far the rim of the outer can has usually become ragged and distorted, so that the funnel sits very uneasily indeed. I have seen one old Glaisher gauge with a heavy stone placed in the funnel to prevent it from being blown off.

My attention was first called to this state of things when discussing the rainfall of London in 1903. One return showed so surprising a figure that I went to inspect the gauge, and found it to be an old Glaisher which had lost its band *c* so long ago that the observer had never known it in any other condition. By comparison with surrounding stations it was found that before 1892 the gauge had agreed generally with others in the neighbourhood, but from that date onward there was a sudden increase which clearly fixed the date of the disaster.

A still more interesting case came before me last year. A group of rain gauges on a Yorkshire moor, much exposed to weather of no very gentle type, had been duplicated in 1901, 5-inch Snowdon gauges having been put down alongside 8-inch Glaisher gauges which had seen long service. The intention was to discontinue the use of the old gauges at the end of six months; but by a lapse of memory they were kept in use for six years, yielding the following interesting comparisons:—

TABLE II.—Comparison of Old Glaisher and New Snowdon Gauges.

Year.	1901.		1902.		1903.		1904.		1905.		1906.	
Gauges.	Gl. ins.	Sn. ins.	Gl. ins.	Sn. ins.	Gl. ins.	Sn. ins.	Gl. ins.	Sn. ins.	Gl. ins.	Sn. ins.	Gl. ins.	Sn. ins.
A	27·51	28·08	26·07	28·03	43·34	45·51	32·17	34·70	31·33	34·29	35·79	39·02
B	26·45	26·33	25·42	25·40	47·27	48·78	29·60	29·56	27·16	26·84	31·23	30·70
C	31·89	31·15	28·29	27·55	55·25	54·57	32·50	32·24	30·83	30·64	36·73	36·59
D	33·72	31·71	32·55	30·01	62·64	57·85	34·46	31·72	33·22	29·87	38·63	36·35
E	32·57	30·91	29·20	25·71	62·72	46·81	41·55	28·32	33·98	24·32	38·21	28·70
F	32·69	26·63	29·70	25·08	58·67	47·31	36·12	28·93	30·51	24·84	37·62	29·73
G	25·92	27·26	24·50	25·41	48·41	47·72	32·20	29·88	34·37	27·43	36·61	30·57
H	27·71	26·83	27·82	27·12	48·95	49·28	31·39	31·16	33·88	28·47	40·99	26·72
Mean of 5 series D to H	30·52	28·67	28·75	26·67	56·28	49·79	35·14	30·00	33·19	26·99	38·41	30·41

When I inspected these gauges I found that the Glaisher gauge in series A was sound, but the rim was much distorted, thereby probably accounting for the smaller amount caught. The Glaisher gauges in series B and C were found to be sound and in perfect order, and they gave the same values as the Snowdon; while in the five series D to H the Glaisher gauges were in a very dilapidated condition. The mean of the series D to H is shown graphically in the diagram, Fig. 5.

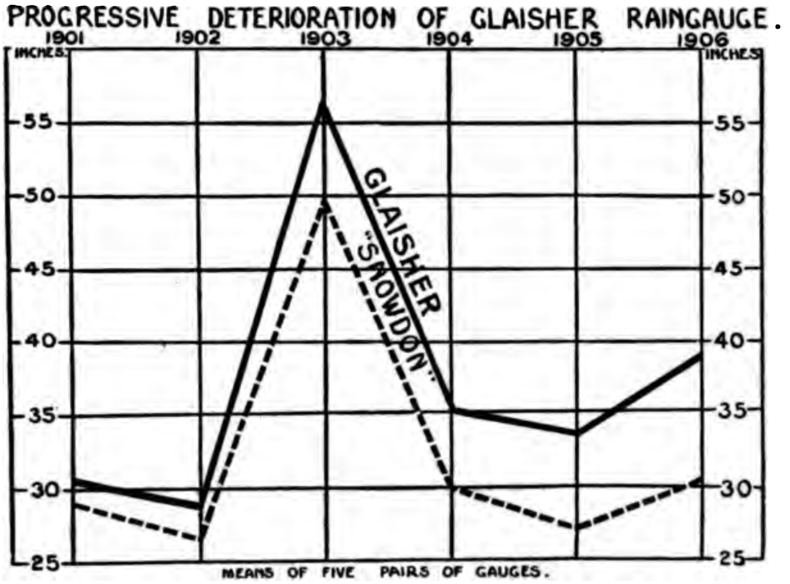


Fig. 5.

For the sake of readier comparison the figures for the Glaisher gauge are transformed in Table III. into percentages of the readings of the Snowdon gauge in the same series.

TABLE III.—Readings of Glaisher Gauges when Reading of Snowdon Gauge is taken as 100.

Year	1901	1902	1903	1904	1905	1906
A	98	93	95	93	91	92
B	100	100	97	100	101	102
C	103	103	101	101	101	100
D	106	108	108	109	111	106
E	105	114	134	147	140	133
F	123	119	124	125	123	127
G	95	96	101	108	125	120
H	103	103	99	101	119	154
Mean of five gauges D to H	106	108	113	117	123	128

The mean of the five gauges is shown graphically on diagram, Fig. 6, in which the straight line at the bottom represents the catch of the Snowdon gauges. The uniformity of the increase in catch of the rapidly deteriorating Glaisher gauges is partly, no doubt, accidental; but the fact

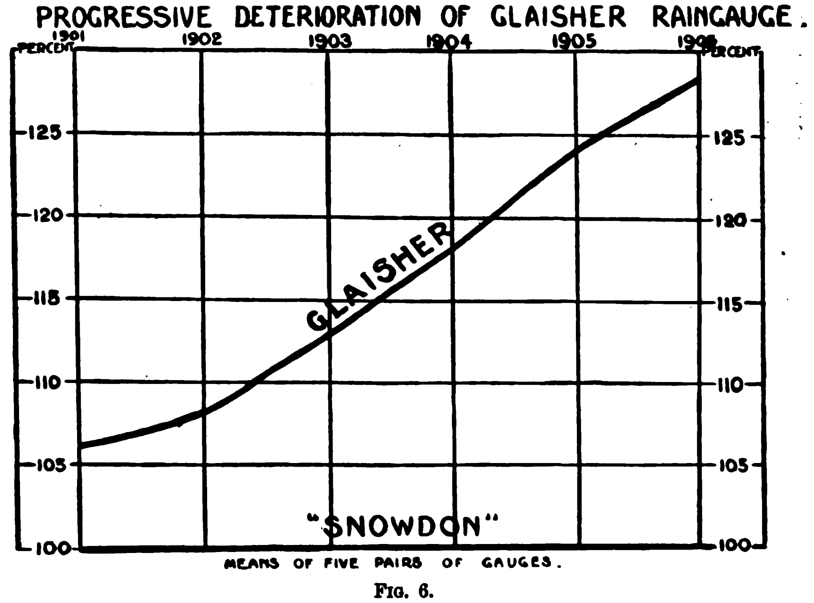


Fig. 6.

that the gauges were growing worse each year is perfectly plain, and at the end of the six years they were actually catching one-quarter more than the proper quantity of rain, a result which, if undetected, might be a very serious matter for a waterworks.

I have carefully avoided history and theory in making these remarks; but as my one object is to promote uniformity and comparability, I take the opportunity of urging that all rain gauges be of standard pattern, and set up so that sufficient of the outer case is buried in the ground to leave the opening of the funnel level and standing one foot above the surface of the grass.

DISCUSSION.

Mr. F. C. **Bayard** remarked that as regarded the Glaisher gauge, Dr. Mill had omitted to mention the effects of frost. The flange in which the Glaisher funnel went when filled with water would freeze during a frost, and the top could not be removed. The only way to get it out would be to wrap hot cloths round and try to thaw it. He thought the Snowdon gauge a very good one, and certainly considered it might be cheaper. If made of galvanized iron instead of copper, it would keep quite as long if painted once in three or four years.

Mr. **Baldwin Latham** remarked that he had a registering 12-inch rain gauge made with a rim having an equal angle inside and out. The rim was made of gun metal, ⅜ in. thick at the bottom. The edge of the gauge was as sharp as a razor. The advantage of having the angle equal inside and outside the gauge was that while the rain might be thrown out of the gauge on one side, it would be thrown in on the other, and he called it an equilibrium rim. He had two gauges, each 8 in., one of the Glaisher pattern and one with an equilibrium rim, but there was practically very little difference in the records. He had, however, found a great discrepancy in the contents of rain-gauge glasses, and thought that all rain-gauge glasses ought to be tested and certified as correct.

Mr. W. **Marriott** said he thought Dr. Mill had done good service in bringing his paper before the Society. There was no question that many gauges were not to be recommended. Wherever possible he, Mr. Marriott, had tried to get observers to use the Snowdon rain gauge with a deep rim, as the gauges with shallow funnels did not collect the proper amount of rainfall, especially during snow. As regarded the Fleming gauge, Mr. Symons had told them that these faulty gauges had led the Manchester Corporation to grant compensation water far in excess of the proper amount, and which they had to buy off for £120,000, because the engineer had calculated the amount of rainfall over the watershed from those gauges, and then had to allow a certain amount of compensation water which did not fall. As the water rose in the can, the stick would also rise above the funnel, and so an increasing surface would be exposed to the wind. With regard to the measurement of the rainfall by a stick, he had himself seen this done at the Royal Observatory, Greenwich, with a Glaisher monthly gauge, a piece of wood being put into the cylinder and the amount of discoloration noted and then measured. The Glaisher gauge at the Royal Observatory was only 5 or 6 inches above the ground, which height was not to be recommended; a rain gauge should be one foot above the ground. He would refer to another point. He had seen at the Army and Navy Stores that afternoon a whole set of rain gauges, some of the Glaisher pattern, some of the "British Association" pattern, and some of the so-called "Snowdon" pattern, though he himself would not have called them so. He thought they might call the attention of the Stores to the fact that the Society had had a discussion on the subject of rain gauges, and suggest to them the desirability of only putting in their catalogues gauges of patterns recommended by the Royal Meteorological Society.

Mr. J. **Hopkinson** said that observers adopting Dr. Mill's advice, rather than throw away their old-pattern gauges, might make good use of them by reading them monthly as a check upon the totals of the daily readings of their new standard gauges. He had an old Howard gauge which he thus read, and it gave a record very close to that of his Snowdon gauge, usually a little less, but occasionally a little more. With regard to errors in the graduation of measuring glasses, observers should have them verified either at the Kew Observatory or by Dr. Mill, and when buying new ones should insist upon having a certificate of their verification.

The President (Dr. H. R. Mill) said that he only wished to refer to two points noticed in the discussion. The first regarded the Greenwich Observatory gauges. He much regretted there was no Snowdon rain gauge there. The shallow-rimmed gauges could not give accurate readings in snow or driving rain. He would like to see a deep-rimmed gauge set up beside the old ones for the purpose of comparison. The second point regarded measuring glasses. These were usually very accurate when made by the best manufacturers, but those obtained in the country with no maker's name upon them were often extremely inaccurate. Mr. Symons had established the practice of testing and giving certificates for gauges and glasses, charging a small fee. This practice was kept up at the office of the British Rainfall Organisation although the fee charged did not cover the actual cost of the time taken in testing, and he had no hesitation in recommending that every glass should be provided with a certificate of correctness either from Kew Observatory or from 62 Camden Square.

The Climate of Eritrea, North-East Africa.

Capt. Tancredi, in an article in the *Rivista Coloniale*, sums up in a useful way our knowledge of the climatic conditions of the Italian possession on the Red Sea, and explains the varying climatic conditions of the several parts of the territory as resulting from their position or relief. The data for the study consists of observations from fourteen different stations, mostly dating only from the last few years, though in the case of Massaua and Kassala there are unbroken series extending over ten and eight years respectively. He points out that the division of zones of altitude corresponding to the popular usage in Abyssinia, the limits of which were laid down by Dove in his work on the climate of that country, will not hold for Eritrea, owing to the marked difference between the seaboard strip up to about 1650 ft. (the Sambar of the natives) and the zone immediately above it. His main divisions, therefore, are (1) the coast zone, (2) the zone of the valleys and escarpments, and (3) that of the high plateau and alpine summits. In the first the conditions are extremely trying to Europeans by reason of the great heat and atmospheric humidity, the latter reaching its maximum in the months of June, September, and October. As a rule, rain falls in the winter months only (November to April). The second zone falls within the régime of summer monsoon rains, but those portions which adjoin the coast zone enjoy the benefit of some winter rains as well. This makes it necessary to subdivide the zone according as the slopes face the seaboard or the Sudan. The soil is fertile, and the water-supply renders vegetation both rich and varied. In the seaboard subdivision the most diverse products are capable of cultivation, according to altitude, but the conditions cannot be said to be favourable to European settlement. On the continental slopes of this zone, which form about three-fifths of the whole area of Eritrea, the climate is more propitious, owing to the comparative dryness and greater variations of temperature due to nocturnal radiation. May is here the hottest month, and August the most rainy. The lower levels have a less copious rainfall, but as a set-off to this the possibilities of irrigation are greater, as the streams, which at higher levels flow far below the surface, here emerge on to less permeable strata. The third zone, above 6000 ft., includes only a small portion of Eritrean territory, within which the highest altitude is about 10,000 ft., and the highest permanently inhabited spot about 8500 ft. The bulk of the rainfall falls in summer (monsoon rain), but a certain amount also falls in early spring. The greatest heat occurs in the dry season (November to May), during which vegetation rests, especially above 8000 ft., at which level the zone may be divided into two sub-zones of somewhat different character.

ON A METHOD AND APPARATUS FOR MEASURING FOG DENSITIES.

By JOSEPH W. LOVIBOND, F.R.Met.Soc.

[Read May 15, 1907.]

The method is based on the power of selective absorption resident in suitably coloured glass. When this has been graded into mechanical scales of equivalent colour value a beam of white light can be progressively absorbed to extinction, and the luminous value of each successive absorption stated in quantitative terms. This analytical power also applies to the colour constituents of the beam.

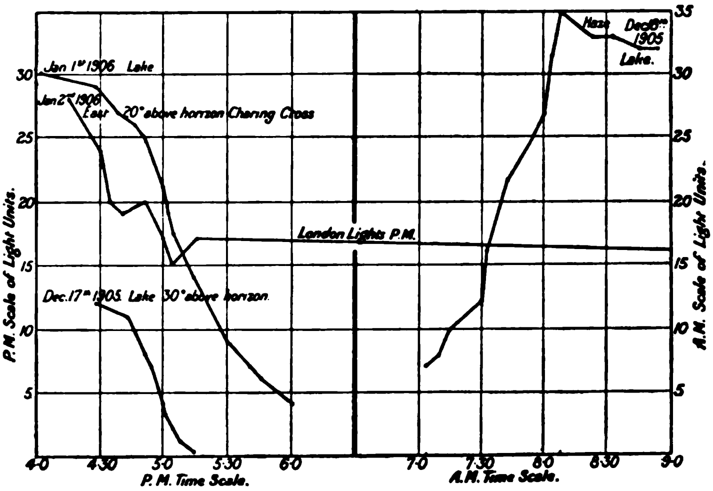


FIG. 1.—Curves of Light Changes.

Examples of the method are shown in Fig. 1 by means of curves illustrating the rates of light increase and decrease by time of Morning and Evening Light. The irregularities in the London curve are caused by the street lights.

The apparatus consists of a platform adjustable to command any altitude (Fig. 2). The objective end is fitted to carry an artificial light and reflectors. The other end carries an optical instrument which commands a view of a screen in the middle. The screen is pierced with two apertures, through one of which the fog is viewed, and through the other the light with which it is to be compared.

The screen is fitted with grooves on one side to receive the matching glass standards, and on the other to receive screens for modifying certain rays in the artificial light and also to bring the light to a known luminous intensity (in this instance it is 22 units).

The necessity for modifying the artificial light is because the rays of direct lights are not in colour accord with those of diffused daylight, which is the standard light for everyday colour work, and is the light

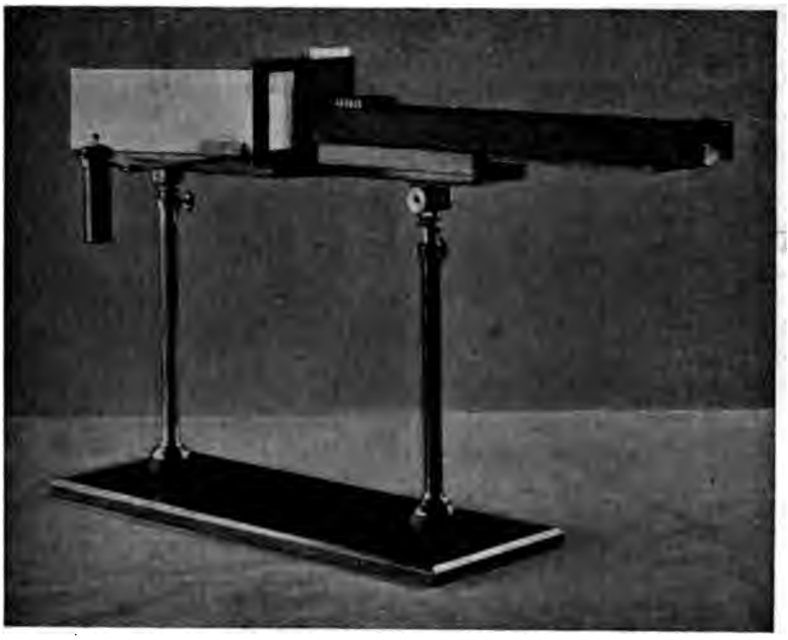


Fig. 2.

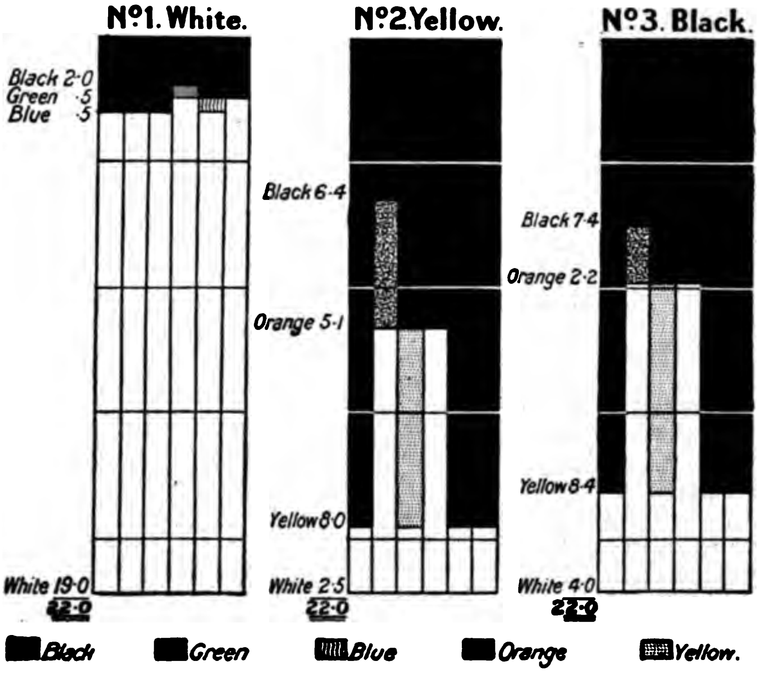


Fig. 3.—Ray proportions of three artificial Fogs.

by means of which the scales of absorbents were standarised into units of equivalence.

The disturbing rays are, however, unstable, and can be modified into working accord with diffused daylight by suitable combinations of concentrators, diffusers, and reflectors. But each artificial light has its own specific variations, and therefore requires separate standardisations. The light used for these demonstrations is that of a standard candle once reflected before transmission through two diffusion screens, which modifies it to a luminosity of 22 units, as already stated.

For the purpose of demonstration, screens have been prepared of combinations of white and brown paper with coloured glass to represent three types of fog (Fig. 3). Each is placed in the apparatus in turn and measured with the following results:—

No. 1 screen representing a white fog is matched by 2 red, 2·5 yellow, and 3 blue standard units. This combination analyses the white light of 22 units luminosity into colour accord with the fog

by absorbing	2·0	white units	(called black)
„ developing	·5	„	as green
„ „	·5	„	as blue
„ transmitting	19·0	„	unaltered
	22·0		

No. 2 screen represents a yellow fog, and is matched by 11·5 red, 19·5 yellow, and 6·4 blue standard units. The standard light is modified by transmission as follows:—

by absorbing	6·4	white units	(called black)
„ developing	5·1	„	as orange
„ „	8·0	„	as yellow
„ transmitting	2·5	„	unaltered
	22·0		

No. 3 represents a black fog, and is matched by 9·6 red, 18 yellow, and 7·4 blue standard units, modifying the light

by absorbing	7·4	white units	(called black)
„ developing	2·2	„	as orange
„ „	8·4	„	as yellow
„ transmitting	4·0	„	unaltered
	22·0		

In demonstrating the absorption of the light by 22 standard units it will be seen that there is still a slight sensation of red left. This red sensation is also a residual factor of diffused daylight, it is unabsorbable by the usual media, and does not appear to influence the colour measurements when in this modified condition.

With a view to convey an idea of the dimensions of the standard light unit adopted, in its relation to some of the objects of everyday life, Table I. has been compiled from a series of atmospherical observations, examples of which are illustrated by the Morning and Evening light curves already dealt with.

The practical use of such work as this depends on the co-relation of

an extended series of observations with the accompanying meteorological conditions, and possibly further information may be gained by means of fog solutions obtained by some form of aspirator, such as was used for establishing the absorption curves of smoke from different kinds of fuel for the Coal Smoke Abatement Meeting of last year. These curves are illustrated by transparency.

TABLE I.

Tintometrical Light Units :—

1. Sky line at 1500 yards just distinguishable.
2.
3.
4. Single trees on sky line just distinguishable at 150 yards (nearly dark).
5.
6. Single trees just distinguishable on intervening landscapes.
7.
8. Single trees easily distinguishable on intervening landscapes.
9. Bushes and sun-dial indistinct at 20 yards.
10. Separate branches on trees distinguishable at 100 yards.
11. Small bushes distinguishable at 50 yards.
12. Small objects on ground distinguishable at 50 yards.
13. All colour gone by evening decrease.
14.
15. Yellow just separable from the light.
16. Blue just separable from the light.
17. Red just separable from the light.
18.
19.
20. All colours easily separable.
21.
22.
23. Colour of near foliage and grass indistinct.
24.
25.
26. All near colours evident.
27.
28.
29. Cannot read *The Times* newspaper.
30. Read with difficulty.
31. Read fairly well.
32. Read easily (daylight).

DISCUSSION

Mr. W. Greatheed thought that any method of measuring light-intensity would advantage town-residents, almost all of whom suffer from a paucity of sunlight. He had for that reason rearranged his working day to between 4 a.m. and 8 p.m., following the astronomical day. Forenoons probably have more light-intensity than afternoons, because the overhead blanket of dust and smoke during the night removes, or precipitates, but during the day it accumulates. He had endeavoured to compare these relative intensities by recording the times before sunrise and after sunset at and till which respectively he could read ; but one met the paradox that without reflecting material in the atmosphere there would be no twilight.

The President, Dr. H. R. Mill, said they were much indebted to Mr. Lovibond for explaining his apparatus. There was more difficulty about the numerical values of fog as usually estimated than anything else. He thought Mr. Lovibond had made very interesting advances towards the numerical treatment of fog density. It would be interesting to have the figures for a year, or longer. He expressed the thanks of the Society to Mr. Lovibond for his valuable paper.

NOTE ON A BALLOON STRUCK BY LIGHTNING, APRIL 11, 1907.

By Colonel J. E. CAPPER, R.E., C.B., F.R.Met.Soc.

[Read May 15, 1907.]

The following account of a meteorological occurrence which took place at South Farnborough on April 11 may be of considerable interest.

This being one of the International Meteorological Observation days, we had a captive balloon in the air carrying a meteorological recording instrument. The balloon was attached to the drum of a wagon by a steel piano-wire; about half a mile of wire was out.

The balloon had been up since about 11 o'clock in the morning. Wind almost due East, light on the ground, and probably from 10 miles an hour to dead calm at different times 2000 ft. above the ground.

About 3.10 p.m. a sudden thunderstorm came up from east-north-east; very thick and heavy, sulphurous-looking clouds. When the storm was noticed it was coming rapidly on, and it appeared to be too dangerous to attempt to get the balloon down. Heavy rain came overhead at 3.15; at 3.20 a sudden flash of lightning took place along the balloon wire. The flash, according to one observer, seemed to travel down the wire till it reached the wagon—there a sudden bright light appeared and ran right up the wire into the clouds in which the balloon was hidden. This light was of a reddish tinge, and as it ran up the wire was followed by thick, heavy fumes of brownish-yellow smoke (another observer called them grey), which hung about for some little time. On going to the winch we found the wire was fused, being burnt entirely away where it first touched the iron pulleys which guide the wire when running out.

A portion of the fused wire was left on one of the pulleys, and this I send, together with a piece taken off what was left of the wire on the wagon, showing how completely the electric spark has eaten away the metal.

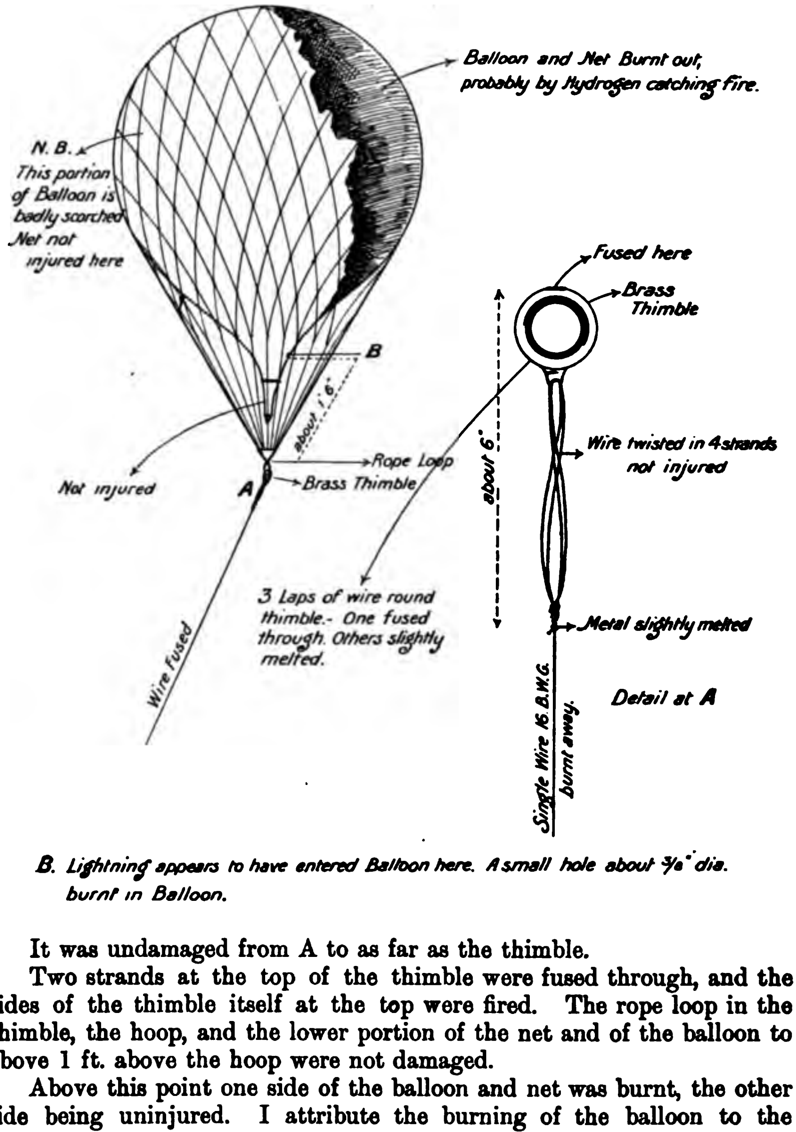
The balloon being up in the clouds at the time, I cannot say whether it also was struck and whether the meteorograph was damaged.

There were several witnesses of this occurrence, which I think is interesting as showing that at any rate in this instance the burning-up of the wire—which as far as one can see was burnt into gas throughout its whole length—took place from the earth upwards, and not downwards as has been sometimes thought was the case.

Mr. S. F. Cody saw the original flash down the wire. Two other men who were looking at the winch at the time did not, but perhaps because they were close to. I was at the exact instant not looking at the spot where the wire was, but I most distinctly saw the burning of the wire from the bottom upwards, which took an appreciable time, something I should estimate not far from three-quarters of a second; and the smoke following it made it impossible to mistake that the burning was really from the earth upwards.

Lieut. Martin Leake, R.E., who was some distance away, distinctly saw the flash first come *down* the wire, and afterwards the smoke rise from the bottom up.

The remains of the balloon were subsequently recovered. The balloon was fastened to the wire as shown in the illustration. The wire was completely gone as far as A, where the knot was slightly fired.


Balloon and Net Burnt out, probably by Hydrogen catching fire.
N. B. This portion of Balloon is badly scorched Net not injured here
B
about 1' 6"
Rope Loop
Brass Thimble
A
Not injured
3 Laps of wire round thimble.- One fused through. Others slightly melted.
Wire fused
Fused here
Brass Thimble
about 6"
Wire twisted in 4 strands not injured
Metal slightly melted
Single Wire 16 B.W.G. burnt away.
Detail at A

B. Lightning appears to have entered Balloon here. A small hole about ⅛" dia. burnt in Balloon.

It was undamaged from A to as far as the thimble.

Two strands at the top of the thimble were fused through, and the sides of the thimble itself at the top were fired. The rope loop in the thimble, the hoop, and the lower portion of the net and of the balloon to above 1 ft. above the hoop were not damaged.

Above this point one side of the balloon and net was burnt, the other side being uninjured. I attribute the burning of the balloon to the hydrogen inside catching fire.

There was about 2500 ft. of wire out at the time. The height of the balloon as shown by the meteorograph was about 2000 ft. It was above the clouds and invisible. It is difficult to say how high the lower layers of cloud were, or whether more than half the wire was below the clouds. I cannot therefore positively state whether the balloon itself was struck by the original flash, and whether the wire was fused from the top downwards as well as from the bottom upwards; but I am inclined to think the whole of the fusing of the wire was from the bottom up.

A corporal near the wagon says he heard a sound like a distant gun explosion about the time the fusing would have reached the balloon (travelling up the wire), and remarked to another man at the time, "That's the balloon bursting."

I should much like to have the opinions of some of the authorities on this circumstance, which is rather revolutionary to my ideas.

I have received other letters about the occurrence. One officer 500 yards off on the golf links, who did not know a balloon was up, is certain the firing started from the bottom, as he thought it was a rocket being sent up. Others 1½ miles off who had been watching the balloon, which was invisible through clouds at the moment, thought the fusing took place from the top. They would at the distance not be able to see the red glow of the wire, and the smoke would not be seen by them until well formed, so I have no doubt they were mistaken. One thought he saw a flash sideways in the cloud to the balloon, or rather to the point where he had last seen the balloon.

ADDENDA

The following are extracts from letters received since the above paper was written.

Capt. G. CROSSMAN says :—

"I will answer your questions as clearly as I can, and will not tell you anything except what we are all absolutely sure about.

"We were watching the place where we had seen the balloon, as some of us were wondering what would become of the balloon in the storm. We then saw a very vivid flash, and afterwards a column of smoke from where the balloon had been to the ground.

"The balloon appeared to be right in the middle of the clouds, and none of us actually saw it burnt. I had seen it myself only a moment before, and I was still looking towards it when the flash came, and we saw the balloon no more. The whole flash appeared to be instantaneous.

"One man who saw it is quite sure that the flash originated above and to one side of the balloon.

"As far as we saw there was only one flash, and then the curious curly column of smoke appeared. We are all agreed that the flash started from the top and *ran downwards*. The balloon was in the clouds, and not above, as far as we could see. But at the moment of the flash we could not actually see it.

"I think there is nothing else I can tell you without telling you things which we are not quite sure of, and which might be the result of our imagination. But if there is anything else we can tell you I am sure any of us would gladly come down and see you about it."

Capt. A. W. INGLES says :—

"I heard that you wanted to know, from some one who saw it, about the fusing of the captive balloon wire during a thunderstorm a week or two ago. I was playing golf about 500 yards away at the time, and practically saw the whole business.

"At the time I did not know of the existence of the balloon or the wire. The streak of fire, rather like a firework, which was the wire fusing, commenced at the bottom and *went upwards*; almost immediately afterwards there was a flash of light at the bottom end and a loud report, rather like the bursting of a shell. I know the wire began to fuse at the bottom end, because I remarked at the time that some one had sent a rocket up.

"I don't know whether this is any use to you, but Crossman of my Regiment was talking about it and said you wanted to know whether the wire began to fuse at the top or bottom first."

DISCUSSION.

Prof. A. S. Herschel referred to the account which he gave at the Meeting of the Society on December 19, 1906 (*Quarterly Journal*, vol. 33, p. 53), regarding a thunderbolt which was asserted to have fallen on the afternoon of August 2 or 3, 1906, in the western part of Northumberland. He read the following letter from Mr. John Nevin written on November 5, 1906 :—

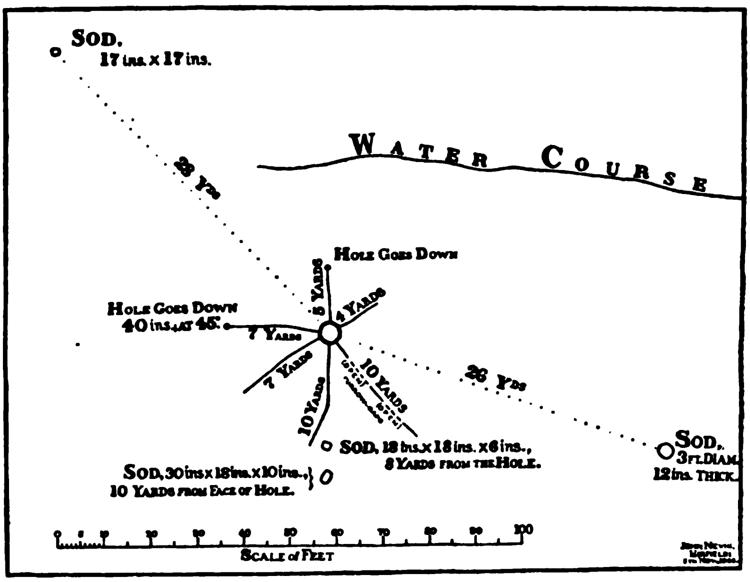


Fig. 1.—Plan of Deep Holes and Furrows bored in Peat by Lightning.

"I am afraid we shall not be able to carry this matter any farther. The moor belongs to Mr. J. B. Lowes of Allan's Green, near Bardon Mill. I was shooting with him on Thursday, August 16, and was asked if I should like to see the place where a thunderbolt had fallen. I found a hole of 4 or 5 feet diameter on a flat part of the moor, full of peaty water to within a foot of the top. There had been continuous rain for a week. Radiating out from the hole were six or seven furrows, looking almost as if they had been cut with the coulter of a plough. Pieces of turf were thrown in various directions ; the largest one, about 3 feet in diameter and 1 foot thick, was lying 26 yards away in an easterly direction, and various other pieces were lying around, within 20 yards of the hole.

"James Turnbull, of Garbutt Hill Farm, told me he was the first to see the place, while looking after sheep on Sunday, August 12.

"I suggested to Mr. Lowes that the hole should be excavated to see if we could find the supposed aërolite, but as this would have disturbed the moor in the grouse-shooting season, the matter was postponed.

"I went over specially on Monday, October 29, and I had Turnbull and Robert Hall, the gamekeeper, with me. Turnbull says that he first noticed the hole on Sunday, August 5, and he thinks that the thunderbolt fell during a thunderstorm on the afternoon of Thursday or Friday, August 2 or 3, but could not be sure which day; and when I first saw the hole in August I understood him to say that he thought the thunderbolt had fallen on Thursday, August 9, but he now puts the date a week earlier.

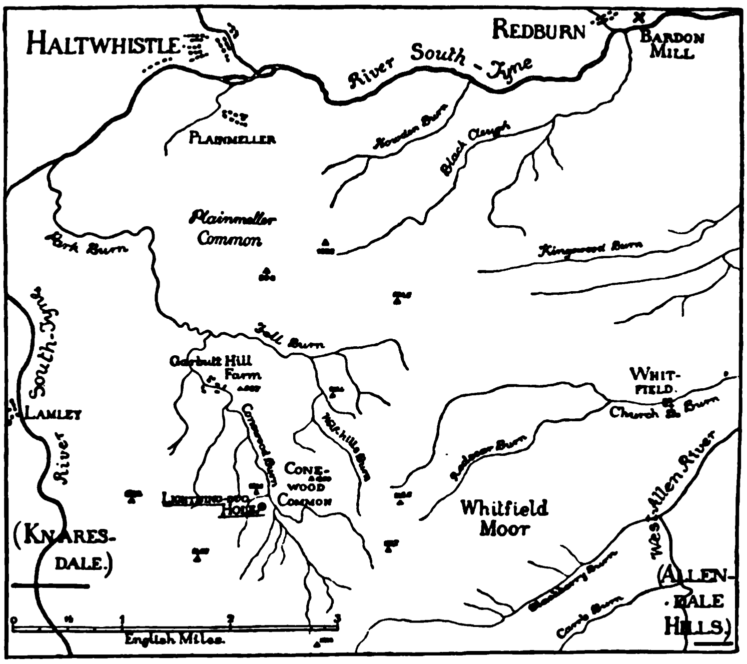


FIG. 2.—Map of the Hole's Position on Conewood Common, near Haltwhistle-on-Tyne.

"Robert Hall, the gamekeeper, has excavated the hole to a depth of 12 feet; it is still in soft peat, but he cannot excavate deeper unless the hole were carefully timbered, as the sides are so soft, and the peat and water run in, and he cannot be sure whether the ground has been disturbed or not, and cannot tell to what further depth the peat may go.

"The hole is now full again within 18 ins. of the top with soft peat and water. He found in excavating the hole, several holes from 1 to 3 ins. in diameter going into the sides, slanting downwards at various angles; one of them he traced for 5 feet, but could not find anything hard at the end of it, or in any of the others which he traced to a less depth. The furrows on the surface also show signs of something having passed along them; in one special case something has gone partly underground, then come to the surface twice, and then underground again, in a distance of 10 yards.

"He says that in the bottom of his excavation there was a hole about 2 ins.

in diameter going down and inclining towards the south-west; he traced this 3 ft. farther with a walking-stick without getting to the bottom of it. This is all the information I can get.

"I know nothing myself of these matters, but the whole thing seems to me as if an extremely hot body had fallen at a high velocity into the wet peat, causing an explosion of steam, which threw the turf all about within a radius of over 20 yards; and which body has burst into small fragments causing these branch holes of 1 to 3 ins. in diameter, which seem to radiate in every direction. I have used a good deal of dynamite, and know that the results are very different from what can be seen here.

"A permanent prevalence of storms and frosty weather had then set in, and constant flooding of the ground by copious rainfalls had effectually brought to a conclusion any contemplated further plans, and put out of the question the possibility of attempting any more to carry on the hole's continued exploration.

"I send herewith a sketch of the holes and furrows (Fig. 1), and also a tracing from the old one-inch Ordnance map, 106, S.E. showing the place (Fig. 2).

"Mr. J. Walton, J.P. of Allendale, tells me that in 1860, when about 10 years of age, he was with his father on a moor about 6 miles west from Garbutt Hill, and about the same distance north from Alston, when a heavy thunderstorm came on. They took refuge under a stack of rushes, and while there his father saw what he described as a red ball of fire, surrounded with a bright light, which fell some little distance away. Next day it was found that some sheep had been killed, and a hole made in the ground; but nobody seems to have had the curiosity to make any exploration.

"I think these phenomena may happen on these moors, away from inhabited places, more often than is suspected."

Mr. A. Hands said that it appeared from Col. Capper's paper a clear case that the balloon was struck by lightning, but whether the discharge travelled up or down would be a very difficult point to decide. A flash probably took somewhere about a two-hundred-thousandth part of a second, and it would be very difficult to judge, by the appearance of it, which way it was travelling. The red appearance referred to was probably the fusing of the wire following the occurrence. One would have thought the wire would have fused instantly instead of gradually upwards. Regarding Prof. Herschel's paper, this resembled one read by the Rev. C. F. Box about a year ago. It was not an uncommon occurrence. Evidently the moisture was turned into steam and the earth blown out of the hole; in a clay soil this would almost invariably happen.

Mr. R. Inwards remarked that there seemed to him no other way for a long wire to fuse through its whole length except from the bottom. The strange point was that though the wire was of steel, the part close to the fusing had not lost its temper or become soft. With regard to Prof. Herschel's paper, he noticed one point, when looking at the plan, viz. the stellar radiate form of the channels formed by the explosion. In Lord Armstrong's book of beautiful photographs of electrical discharges on coated plates there were about 50 diagrams of the effects of actual sparks, both positive and negative, and all of these were of a stellar or radiate character, to which the plan submitted by Prof. Herschel bore a more than slight resemblance.

Mr. E. Gold said he disagreed with both Mr. Hands and Mr. Inwards on the subject of Col. Capper's paper. Mr. Hands had suggested the possibility of a discharge taking place along the wire, which afterwards fused the wire upwards slowly enough to be followed by the eye. He did not think the time difference, if it existed, would be sufficient to be detected by the eye. With regard to Mr. Inward's argument, that a wire must fuse from the bottom upwards, because if it started from the top the wire would fall to earth, and there would be left no wire to fuse, he would like to point out that the discharge would have reached the ground and fused the wire before it had time to think of beginning to fall. Personally he thought Lieut. M. Leake's account represented what took place, viz. that a single discharge took place along the wire, and the vapour due to the fusing of the wire rose upwards. The vapour, of course, would rise whether the wire fused instantaneously or no. Lieut. Leake was far enough away to see the whole of the fused wire at once, whereas the other spectators could see it all only by raising the eyes; and he thought it probable that the apparent fusing upwards was an optical delusion, the idea of the upward motion being intensified by the rising vapour. He thought the experiment was not conclusive enough to warrant the conclusions drawn in the paper.

Mr. W. B. **Tripp** remarked that with regard to Prof. Herschel's paper, some years ago a paper containing accounts of similar occurrences was brought before the Society "on the non-existence of thunderbolts," by the late Mr. Symons. Generally some conducting material was found at the bottom of the excavation made by the lightning, and this was, in such cases, considered to be a veritable thunderbolt.

Prof. A. **Herschel** inquired whether the wire referred to in Col. Capper's paper was galvanised. When a strong galvanic current was passed through galvanised wire the first effect was to set fire to the zinc from end to end, which would produce a brilliant display of white light, when the inside iron would melt too, and produce a second display of intense brightness. (Having examined the specimen of the wire supplied by Col. Capper with his paper, Prof. Herschel found it to be quite plain, tough-drawn, 16 B.W. Gauge steel wire. The two successive flashes apparently well seen upon the wire, the first shooting swiftly down it, and the second travelling rather more slowly up it, could not evidently, therefore, be so accounted for.)

The President (Dr. H. R. **Mill**) said he wished to thank Col. Capper for his interesting paper, and Prof. Herschel for his kindness in coming there, though very unwell, to read his account to them. He would like to add a word with reference to his own paper, and that was to thank Messrs. Casella and Messrs. Negretti and Zambra for sending up samples of rain gauges for exhibition, which he considered the more praiseworthy, as they had also included specimens of those types of gauges to which he was objecting.

Kites struck by Lightning, July 10, 1907.

These accidents are very interesting, as one occurred at Salisbury Plain and one at Farnborough, Hants; the time of the one at Salisbury Plain is a little uncertain, but it was in the forenoon, probably about 11 o'clock—nearly the same time as the accident at Farnborough.

Farnborough Case.—One kite only was up, with a Dines meteorograph in it.

The bridle lines of the kite were attached direct to a brass thimble fixed on the end of a piano-wire.

No flash was seen, but it was suddenly discovered that the kite was loose. The kite was recovered undamaged, but both bridle lines were burnt through.

The bridle lines were wet. They consist of cord approximately $\frac{1}{4}$ in. in diameter. The lines were burnt through, one at 4 ins. and one at 10 ins. from the thimble; at 14 ins. from the thimble both lines were fastened together, and from that point ran as a double line to the thimble. The bridle lines are about 9 ft. long.

The weather was reported stormy.

Salisbury Plain Case.—The kite was fastened on to a $\frac{1}{4}$-in. diameter rope

300 ft. long; the lower end of this rope was attached to the end of a steel wire cable of about $\frac{7}{8}$ in. circumference. At 2 ft. from the cable there are marks of burning on the rope; at 11 ft. from the cable the rope was burnt through. The remainder of the rope appears to be uninjured. This rope also was very wet.

No flash was seen. The weather was not apparently thundery, and man-lifting was in progress at the time.

Heavy rain came on shortly afterwards.

In neither case was the wire damaged. In each case the winch containing the wire was well earthed.—J. E. Capper, Colonel, R.E., S. Farnborough, July 12, 1907.

Balloon struck by Lightning, July 22, 1907.

Col. J. E. Capper has forwarded the following report by Mr. S. F. Cody on the striking of a balloon by lightning at Farnborough :—

At about 11 a.m. on Monday, July 22, a captive balloon carrying meteorological instruments was in the air. Some 4500 ft. of 19 S.W.G. tin-plated piano-wire was between the balloon and the winch. The balloon was probably about 3500 ft. high. The winch was exceedingly well earthed, standing on a large solid iron plate, which was also buried about $1\frac{1}{2}$ ft. in the earth.

I was trying to locate the balloon, which was hidden by clouds at the time, when a flash of lightning came, crossing horizontally, and then a quick stroke to the earth.

Being unlike anything I have ever seen before, I set about inquiries to find out whether the wire had been struck or not. No smoke appeared from the flash. There was a deep hissing noise, followed by the natural crash of the thunder some seconds afterwards.

The hissing noise was probably the wire falling, as it was in many cases driven two or three inches into the earth.

I was about 180 yards from the winch in the same direction as the wire, and about 40 yards from directly under the wire to the left, looking from the winch.

The balloon went away free, carrying the instruments, and was watched for several minutes, as it happened to pass through a clear portion of the sky where no clouds were at that time. It has not since been recovered.

On investigation of the wire I found that near the winch, say about 250 yards from it, the wire became less tempered—in fact it would stand bending quite well in the portions found near the winch. It was fused right off at the first wheel of the winch, and was undamaged at the drum of the winch.

The weather was sultry; there had been some rain. The wind was light but squally, West-north-west. There had been no lightning previously.

The following are some observations taken on the ground about an hour before the wire was struck :—

Dry Bulb	64°·4
Wet ,,	60°·4
Barometer	29·85 ins.

Wind North-west to West-north-west.

THE RELATION OF THE RAINFALL TO THE DEPTH OF WATER IN A WELL.

By CHARLES P. HOOKER, L.R.C.P., F.R.Met.Soc.

[Read June 19, 1907.]

FOUR years ago I had the honour to read a paper on the relationship between the rainfall and the depth of water in a well at "Further Barton," Cirencester[1]; and though the time seems short since then to reintroduce the subject, still, as I fear this will be the end of my observations, the subject of our water-supply is of sufficient importance to warrant my bringing my results to the notice of the Society.

Further, these four years have been unusually interesting, including, as they do, the remarkably wet year 1903 and the droughty summer and autumn of 1906, which must be still fresh in your recollections.

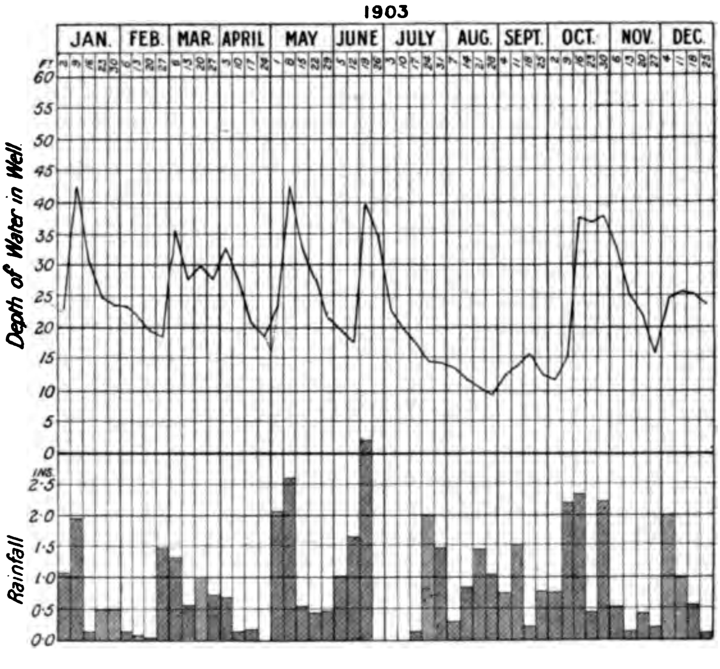


FIG. 1.

In my previous paper I ventured to draw the conclusion that the effect of even prolonged rainy periods was of a far more temporary character than is generally supposed, and that the cause of short autumn water-supplies was not to be found in the deficiency of rainfall in the previous winter, but that lack of spring rains and subsequent heat and drought were more important factors. I venture to think that the records of these four years amply verify my conclusions.

To begin with 1903. As will be seen from Fig. 1, the water-level in the well shows a most unusual tracing; but if it be compared with the rainfall of the same time, I do not think it can be claimed that the previous winter's rain is the cause.

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[1] *Quarterly Journal of the Royal Meteorological Society*, vol. xxix. p. 263.

The well was practically full the whole year, being constantly added

TABLE I.—RAINFALL OF PRECEDING SEVEN DAYS, COMPARED WITH DEPTH OF WATER IN THE WELL.

Week ending	Rain-fall.	Depth in Well.	Week ending	Rain-fall.	Depth in Well.	Week ending	Rain-fall.	Depth in Well.	Week ending	Rain-fall.	Depth in Well.
1903.	in.	ft. in.	1904.	in.	ft. in.	1905.	in.	ft. in.	1906.	in.	ft. in.
Jan. 2	1·04	22 5	Jan. 1	·01	17 2	Jan. 6	·21	7 9	Jan. 5	1·01	16 8
9	1·91	42 5	8	·68	15 3	13	·45	7 2	12	1·62	31 2
16	·14	30 4	15	1·29	25 7	20	·25	7 0	19	1·59	37 1
23	·50	24 11	22	·14	29 5	27	·01	9 10?	26	·38	32 11
30	·50	23 5	29	·76	25 3	Feb. 3	·04	?	Feb. 2	·03	27 3
Feb. 6	·15	23 1	Feb. 5	1·64	37 10	10	·11	6 4	9	·28	25 7
13	·06	21 5	12	2·48	57 3	17	·09	6 1	16	·82	20 2
20	·03	19 2	19	1·37	43 3	24	·12	5 10	23	·62	21 1
27	1·57	18 5	26	·42	32 2	Mar. 3	·63	8 10	Mar. 2	·39	23 6
Mar. 6	1·30	35 4	Mar. 4	·52	28 3	10	1·09	9 11	9	·24	18 7
13	·57	27 5	11	·55	25 1	17	2·42	27 9	16	1·28	23 7
20	·99	29 4	18	·01	24 0	24	·52	30 1	23	·20	22 3
27	·71	27 5	25	·06	19 4	31	·40	25 3	30	·26	20 1
Apr. 3	·68	32 9	Apr. 1	·65	19 2	Apr. 7	·30	21 7	Apr. 6	·11	17 10
10	·14	27 4	8	·61	17 3	14	1·49	21 11	13	·05	14 2
17	·17	20 4	15	·48	17 2	21	·24	21 7	20	·04	13 5
24	...	18 6	22	·26	16 4	28	·28	19 2	27	·38	13 2
May 1	2·07	23 3	29	·09	16 2	May 5	·57	17 2	May 4	·56	12 1
8	2·61	42 7	May 6	·46	14 11	12	...	17 2	11	·31	10 1
15	·57	32 6	13	·43	13 8	19	·05	10 11	18	·13	10 0
22	·42	27 6	20	·02	12 5	26	...	10 9	25	·87	10 2
29	·47	21 3	27	1·05	11 4	June 2	·17	10 7	June 1	·88	9 4
June 5	1·01	19 2	June 3	1·48	11 2	9	1·08	10 2	8	...	7 5
12	1·62	17 8	10	·12	9 10	16	·50	8 11	15	·03	7 4
19	3·20	39 2	17	·51	10 2	23	·89	8 10	22	·81	7 2
26	·01	34 4	24	·13	9 1	30	·47	7 6	29	2·28	6 9
July 3	...	24 6	July 1	·32	8 10	July 7	1·34	6 11	July 6	...	7 6
10	...	19 4	8	·66	7 6	14	·37	6 9	13	·20	6 10
17	·16	17 2	15	...	5 6	21	...	6 9	20	·42	6 4
24	2·00	14 10	22	·07	4 8	28	·13	6 9	27	·35	6 2
31	1·47	14 2	29	2·08	5 4	Aug. 4	1·47	4 11	Aug. 3	·71	5 2
Aug. 7	·30	13 4	Aug. 5	1·11	4 6	11	·45	4 9	10	·31	4 8
14	·83	11 6	12	·55	...	18	·81	...	17	·44	...
21	1·43	10 2	19	·96	5 2	25	·30	4 8	24	·10	4 0
28	1·03	9 1	26	1·15	4 9	Sept. 1	1·65	4 8	31	·16	2 4
Sept. 4	·74	12 2	Sept. 2	·08	3 8	8	·93	4 8	Sept. 7	...	1 6
11	1·51	13 9	9	·75	4 1	15	·60	3 9	14	·34	1 5
18	·21	15 6	16	1·48	3 8	22	·01	3 6	21	·40	1 4
25	·78	12 2	23	...	3 7	29	·07	3 2	28	...	0 3
Oct. 2	·76	11 10	30	·16	4 6	Oct. 6	·37	2 6	Oct. 5	2·07	1 6
9	2·19	15 2	Oct. 7	·83	4 6	13	·13	2 5	12	1·56	1 8
16	2·32	37 2	14	·12	3 4	20	·28	2 3	19	1·24	1 9
23	·44	36 1	21	·21	3 2	27	·13	2 0	26	·10	2 10
30	2·22	37 2	28	·11	2 4	Nov. 3	1·40	2 4	Nov. 2	·64	3 2
Nov. 6	·55	32 6	Nov. 4	·04	2 3	10	·50	2 6	9	2·10	5 5
13	·15	24 11	11	1·37	0 10?	17	1·42	2 10	16	·17	10 4
20	·41	21 10	18	·03	2 8	24	·37	5 0	23	·93	16 1
27	·20	15 8	25	·54	1 10	Dec. 1	1·18	7 6	30	·06	19 2
Dec. 4	1·99	24 3	Dec. 2	·01	2 7	8	·51	17 4	Dec. 7	·49	17 8
11	·00	25 2	9	·96	4 11	15	·04	16 4	14	·56	17 5
18	·55	25 0	16	1·01	6 3	22	·17	16 2	21	·61	17 2
25	·10	23 2	23	·04	14 1	29	·19	16 1	28	·61	17 1
			30	·15	8 11						

to by heavy falls of rain, which, except for a short period in early August, following a month's drought, could always penetrate.

The year's rainfall was 45·19 ins.

TABLE II.—Annual Rainfall with Maximum and Minimum Well Depth.

Year.	Rainfall.	Max. and Date.			Autumn Min. and Date.		
	in.	ft.	in.		ft.	in.	
1903	45·19	42	7	May 8	9	1	August 28
1904	30·40	57	3	February 12	0	10	November 11
1905	26·87	30	1	March 24	2	0	October 27
1906	29·88	37	1	January 19	0	3	September 28

1904 (Fig. 2).—When the rainy period—which may be said to have extended from the commencement of 1903 to the end of February 1904—ended, the rest of 1904 was dry, though August was wet; and on November 11 there were only 6 ins. of water in the well, though, granting an error, I am content to say 1 ft. 10 ins.

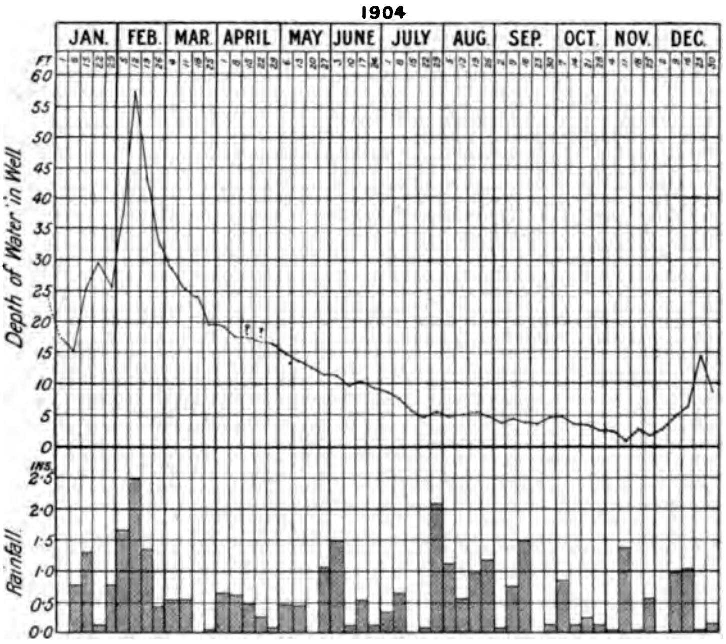

FIG. 2.

Now what had become of all that rain? We heard a good deal before that time of a deficiency of rainfall being the cause of our country's shortage. Now in that period of 14 months' soaking we had no less than 17½ ins. of rain above the average,—more than half as much again as usual,—yet only 8 months after the rains had ceased we had less water in the well than in the autumn before they started.

I am told that this is a sensitive well. Doubtless it is, but it is an excellent gauge to the quantity of water in the Thames, so I suppose that the river is sensitive too.

The previous winter's rain (1903-4) was no less than 22·91 ins., and the year's rain was 30·40 ins.—only 1 in. below the average.

The winter 1904-5 was exceptionally dry, only 11 ins. of rain falling. Yet the subsequent minimum was only 2 ft.—actually higher than the previous year, which, as I have just shown, followed a winter's rain double this one. In this dry winter the maximum height of water in the well was 14 ft. On December 23 and during January and February there was never more than 10 ft. of water.

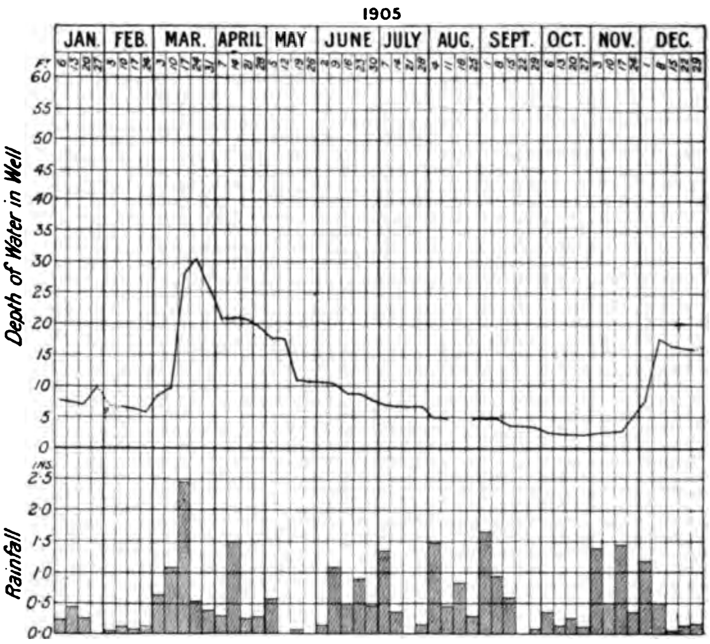

FIG. 3.

Now this year ought surely to have been one of unparalleled scarcity if the old idea, that winter rains are essential, is true; but what do we find?—a soaking March and fairly wet April filled the well up (30 ft. on March 24), and the lowest point (2 ft. on October 27) was actually higher than the previous year's record.

TABLE III.—THE AVERAGE HEIGHTS OF THE WATER IN THE WELL, COMPARED WITH THE SUBSEQUENT MINIMUM.

Year.	January.	February.	March.	April.	Autumn Min.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
1903	29 0	20 6	29 7	24 9	9 1
1904	22 6	42 7	24 2	17 2	1 10
1905	8 0	6 0	20 0	21 1	2 0
1906	29 5	23 6	21 7	14 8	0 3

Further, the year's total rainfall (26·87 ins.) was 3¾ ins. less than in 1904.

The reason for the better supply was that the well was filled later, viz. in March and April; and if we compare the average April depths of the two years,

17 ft. 2 ins. in 1904 21 ft. 1 in. in 1905

we shall see the true reason for the well holding out better.

1906 (Fig. 4) we remember as a year of severe drought and heat, but the autumn scarcity was not due to lack of previous winter rains,—there were 4¼ ins. more rain than in the winter before, and the well was far fuller in January (37 ft.); but the spring did not help the well much, and the average depth in April was only 14 ft. 8 ins., which gave the well a bad start. April was a drought,—in fact June was the only wet month, and though its rains were of inestimable value to crops, they were quite insufficient to influence the well, which, from the heat and drought, sank lower and lower, till on September 28 there were only 3 ins. of water.

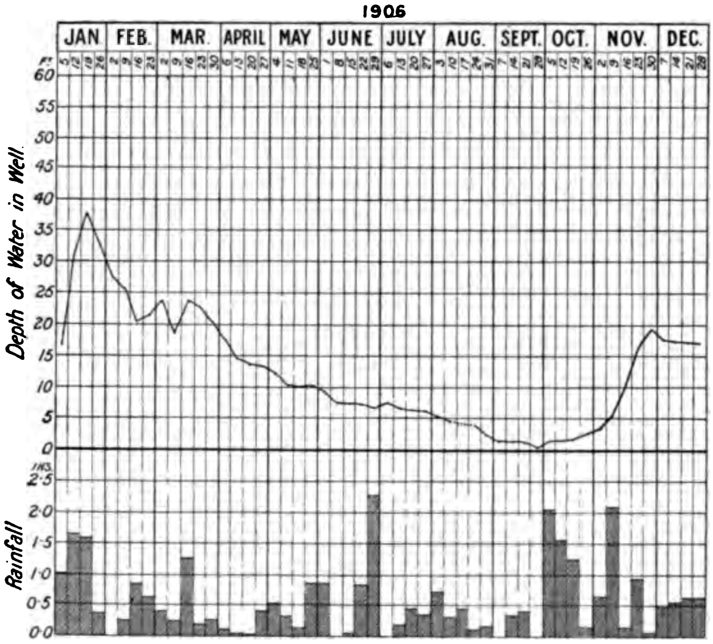

FIG. 4.

In my previous paper I remarked that March seemed a critical month; I am inclined to say now, "and April are critical months."

The year's rainfall was 29·88 ins.—about 1½ in. below the average. Now in my previous paper I quoted that the Water Companies supplying London had taken in July 1902 approximately two-fifths of the water from the Thames. Last September, out of 248 odd million gallons, 143 odd million gallons were taken,—more than half,—and I presume that, as time goes on, even more than that proportion will be taken. Surely I may be allowed to again say, "Store the winter rains."

TABLE IV.—THE WINTER RAINFALL (OCTOBER 1 TO MARCH 31), COMPARED WITH THE SUBSEQUENT MINIMUM WELL DEPTH.

Winter.	Total Rainfall.	Subsequent Minimum.
	in.	ft. in.
1902-3	17·03	9 1
1903-4	22·91	0 10
1904-5	10·96	2 0
1905-6	15·30	0 3

It may be useful to repeat the following particulars respecting the well, which were given in the previous paper:—

"Further Barton" is situated on an elevated plateau about 60 ft. above the town of Cirencester, which is at the foot of the Cotswold Hills.

The height above sea-level of the well mouth is 421 ft., and it is 101 ft. deep. The upper 60 ft. pass through the loose oolitic rock of the district, the lower 41 ft. through Fuller's earth: this forms a large bed extending over several square miles of varying depth and thickness, so that the well dips as it were into a large water-holding area, from which the Thames itself rises. In fact, the well is only about two miles from what is known as Thames Head, and the flow of the underground water is probably in that direction. The depth of water in the well is measured every Friday morning about 11 o'clock, and the rainfall with which it is compared in the tables is that which has fallen in the week preceding, including that measured the same morning at the usual hour, 9 o'clock.

I fear I cannot continue these records. Death has removed the kindly owner of the well, and it is to be closed. I can only hope that these few observations of mine will stimulate others to pursue the subject, as I am sure that many years will not elapse before our water-supply will become a burning national question, and then any small contribution that bears on the subject will be welcome.

DISCUSSION.

Mr. **BALDWIN LATHAM** said he was very much indebted to Dr. Hooker for the continuation of these records. They had had this record from an early period. The original records of this well had been lost, and he himself had supplied a copy. This well differed from most others, as it was extremely sensitive to rainfall, which was not the case with wells in chalk or sandstone. He believed a thorough investigation of the question of wells would throw much light on the subject of crops. He thought that water percolated in excess in some years, robbing the earth of its nutriment, and consequently they did not get such good crops. Farmers could not carry out percolation experiments, but they could measure their wells, which would give most valuable information as to the period when percolation is going on and likely to cease. Now the water is beginning to rise in some of the deep wells in chalk; this meant they would have a very healthy period for some time to come. A certain kind of percolation was due to condensation, the temperature of the ground being cooler than the air, and went on in summer; but this year percolation was going on which was due to rain passing through the ground, and consequently many wells were rising. He was very sorry these well records at Further Barton were likely to cease, and trusted that people would realise the value of these underground water records. He regretted to say that a large proportion of the wells which he had measured had been filled up. For one which had been recently filled up there was a daily record for over thirty years. The records which had been taken were often carelessly treated, and in one case had been sold and used for butter-paper!

Mr. R. H. HOOKER admitted the sensitiveness of this well; but as it plunged below the oolite into what might be called the reservoir of the Thames the depth of water was largely a gauge of the amount there would be in the Thames, and it was thus of peculiar importance to Londoners.

THE PRESIDENT (Dr. H. R. MILL) said they would all unite with him in thanking Dr. Hooker for his interesting paper. He could not quite agree with Mr. R. H. Hooker, however, that this well was a gauge as to the amount of water flowing into the Thames.

Flickering Lightning.

Mr. Alexander Larsen has contributed a very interesting paper to the *Smithsonian Report* for 1905, on "Photographing Lightning with a Moving Camera," in which he brings forward certain facts to account for the "flickering" of lightning flashes. A number of photographs of lightning were taken by a specially arranged moving camera, and almost all of them show the multiplicity of a flash. The average number of rushes for each flash is about five or six, and the time varies from an almost instantaneous value up to about half a second for a complete discharge.

The most interesting discharge obtained was that taken on September 1, 1905, at 9 p.m. The storm during which this flash was photographed began about 7 p.m. with the wind North-east, which is something very unusual for Chicago. The wind gradually changed to North and North-west. The temperature during the storm was about 75°, and the barometer varied between 29·89 and 29·92 ins. The flash was obtained when the storm was most severe and while it was raining very hard.

This flash is composed of forty separate discharges, made up of one band, which in all probability is composed of a number of separate rushes or oscillations very close together and one black discharge. It is this dark discharge which makes this flash interesting, and the photograph shows it running parallel and on both sides of the first bright rush. From this black discharge issue several side branches on both sides, a large one spreading out over the other rushes quite prominently. These side branches all pointing downward indicate that the black flash was a downward stroke, and they also tend to prove that it must have had a good deal of resistance to overcome. It must have cleared the way for the bright discharge, which in all probability proceeded from the ground upward.

An interesting question here presents itself. Have we here two separate discharges with different rates of oscillation travelling the same path? Can such a condition be possible? Mr. Larsen considers the most plausible explanation would be that the two discharges occupied two separate paths, one inside of the other; one discharge forming, so to speak, a tube through which the other passed.

It may also be claimed that the bright flash is probably part of the dark discharge for some reason rendered more luminous. This explanation may be the true one, although it appears as if the bright flash is entirely separate. The measurements of the width of the upper and lower parts of both flashes confirm this opinion, the difference in width of the bright flash being 40 per cent and for the dark discharge only 20 per cent. Authorities vary in their opinions as to the probable cause of these dark flashes. It has been suggested by some that there really are no black discharges, but what appear as such are excessively bright flashes causing a reversal of the image on the plate. This explanation may be the true one, if we understand the word "brightness" to mean increased actinic power of the light.

It was at first thought probable that we had to deal with an interference phenomenon, but that idea was discarded. Then it was suggested that the black discharge was probably due to slow oscillations (the width of it would tend to confirm this opinion), and that what appeared as black on the plate would in reality be a dark red discharge on a partially illuminated background. This opinion had to be discarded for the reason that, if such be the case, the side branches of the dark flash would have been obliterated by the other rushes following. The effect of halation and solarisation was also considered, but rejected. There was thus but one way to account for the phenomenon, namely, that the flash must have given out light of a wave length much shorter than the wave lengths of visible light, and with a power sufficient to render the portion of the plate struck by it non-sensitive to ordinary light. Such a flash would appear black on a partially illuminated background, or be invisible.

Display of Phosphorescence.

The Director of the Meteorological Office has forwarded the following extract from a letter from Mr. S. C. Patterson, second officer, P. & O. s.s. *Delta*, respecting a remarkable display of phosphorescence in the Malacca Strait:—

On March 14, 1907, at 2 a.m., the ship being in lat. 5° 43′ N., long. 97° 55′ E., an unusual phenomenon occurred. I noticed shafts of pale yellow light moving rapidly over the surface of the water. During the major part of the time the shafts seemed to move round a centre—like the spokes of a wheel—and appeared to be about 300 yards long; the appearance being very similar to that of the reflection of a powerful electric quick-flashing light (of the type of Ushant), thrown on the clouds on a dark clear night, but the motion of the flashes was faster, and the interval between them much less. At other times the flashes appeared to come in waves one behind the other.

The sea at the time was smooth, and the sky cloudy; the temperature of the air 83°. The water was slightly phosphorescent in a dull monotonous way, but no signs of brilliant patches. The phenomenon lasted about half an hour—during which the ship travelled 6 to 7 miles—and then suddenly stopped.

The weather did not appear electrical, and there was no lightning throughout the watch, nor were the compasses affected in any way.

THE "STEP" ANEMOMETER.

By WALTER CHILD.

[Read May 15, 1907.]

For more than sixty years the Robinson Anemometer has been in daily use, and we still employ it in the identical form given to it by the Dean.

When we consider its simplicity, its symmetry, its great convenience, requiring no setting, little attention, registering continuously winds from every direction, and its visibility at a distance, it is no wonder that it is a general favourite and that Munro considered it perfection. But, though of great merit, it is not perfect. We know now that the original "constant" of 3, as settled by the inventor, is far too high. The authorities at Kew have finally decided to use the figure 2, and Mr. Dines's experiments indicate that, at times, 1·85 is nearer the truth. If a "constant" may thus alter in amount, one is tempted to ask for a new definition of an "independent variable."

The shortcomings of "the Robinson" are two: its results apply only to the motion of one thin, horizontal stratum of air; and they are, as is nowadays well known, vitiated by the "sheltering error." This is especially the case with high winds. With a hemispherical cup the wind-pressure on the hollow base is said to be about thrice that on the dome (2·5). The Robinson turns, therefore, constantly in such a sense that the domes are always leading.

The cups in their revolution set the contiguous air in rotation in the same direction; thereby the resistance to the motion of the cups is lessened, and this effect culminates during a gale. The instrument, on this account, registers what actual wind there is at too high a velocity. But it does more, for, when the wind drops, then the instrument runs on, by the inertia of its parts, and registers wind when there is none; so that, on this ground also, the results registered are too high. Further, the instrument tends to equalise, or tone down, the fluctuations of the wind, and to show a uniformity which does not exist. How violent and how frequent these fluctuations may be, can be seen by observation of light, free bodies—streamers, smoke from factory shafts, etc. It must be borne in mind that so long as the wind is steady or increasing, then the *cup sides* are the working sides; whereas, at the very moment when "overrunning" begins, then the *dome sides* suddenly become the working sides, and, the resistance to the dome being so much less than that to the cup, the instrument tends to make many turns before coming to rest.

The "sheltering error" varies with the specific gravity, size, and number of the cups and the length and diameter of the radial rods, etc.

In 1904, the writer found, on the whirling table, that for a set of four hemispherical cups of celluloid, 3⅞ ins. diameter, 60 ins. between centres of opposite cups, ⅜ in. cylinder wooden rods, the sheltering error was about 10 per cent in excess of the truth. With the proportions and materials adopted in the standard sizes of the Robinson, viz.

3-in. cups: 10·5 ins. centre to centre,
9-in. cups: 33 ins. " " "

it would evidently be much larger, say 20 per cent, and at high velocities 30 per cent or more.

The moment of momentum $= a\text{MR}^2$, and it is of importance to reduce this quantity to a minimum. It is therefore suggested to reduce the *number* of the cups to three only. This would effect a reduction in weight of nearly 25 per cent. By using aluminium (unobtainable in 1846), "magnalium," or other light alloy, a further reduction of 50 per cent would be made. Celluloid cups up to 4 ins. the writer has found convenient and durable. With regard to the *shape* of the cups the writer made a series of trials on the whirling table last year, with the result that the hemispherical shape could be so altered as to lighten the cups by 25 per cent, while still presenting the same base area to the wind. In addition, it was found that the new shape so evolved, if with the same base area, had an increased resistance, so that the final result was equivalent to lightening the cups by 40 per cent.

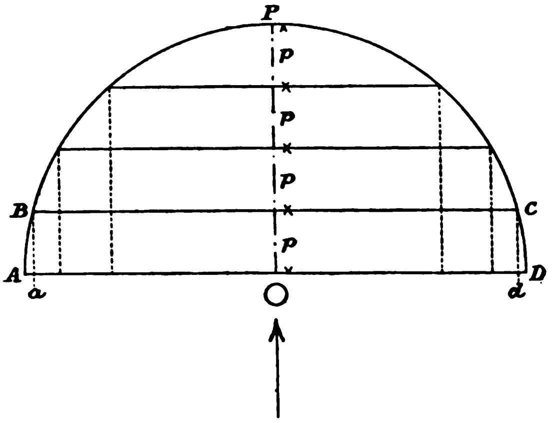

FIG. 1.

With reference to Fig. 1, let APD be the plan of a hemispherical cup, divided into four zones of equal height p; and let the arrow show the direction of the wind. Consider the zone ABCD. If it were removed bodily from the hemisphere it would leave a new cup BPC, whose base $\text{BC} = ad$ is nearly as large as the original base AD, and therefore the resistance nearly the same as before (taking only *areas* as the basis of comparison), whilst the weight of the new cup will be 25 per cent less.

Various fractions of a hemisphere were thus tried as cups on the whirling table, and a height of ¾ radius was found to yield the best result. The extra resistance accruing to the new cup arises, so the writer believes, from a greater disturbance of the stream lines at the new edge, owing to the slight increase in the angle at which it now meets the wind. A paraboloid might prove better still, but as yet this point has not been settled by experiment.

We now approach the question of *diameter* of cups compared with length of arm. Supposing that the "sheltering error" were eliminated, it would seem beneficial to reduce the relative length of the arms. Such reduction would reduce the moment of momentum of the system. Its limits would need to be determined, on the whirling table, by a special set of experiments directed to that end.

With reference to the "Step" model exhibited (Fig. 2), it may be stated that, in view of the complexity of the problem, it was considered advisable to adhere strictly to the old standard size, shape, relative position, weight, material, finish, and number of the cups and arms; so that any difference in behaviour in the step model when compared with the performance of the standard at Kew might safely be ascribed to the single alteration made, *i.e.* to the "stepping" of the four cups and to no other cause.

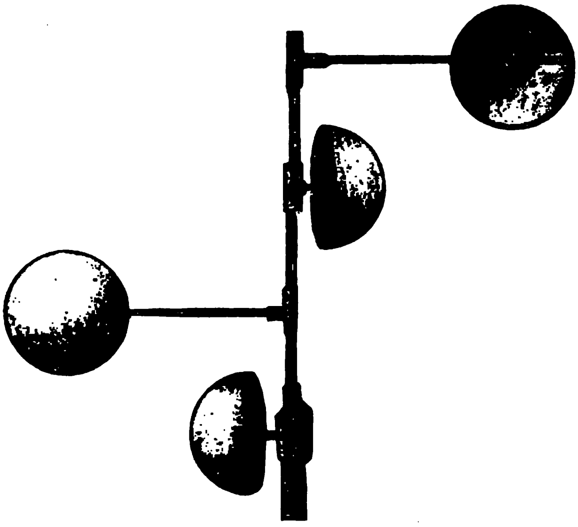

FIG. 2.

The instrument shown was accordingly tried at Kew, and the Kew results are appended. As anticipated, it shows some 25 per cent less than the standard; and this discrepancy, so the writer submits, is the "apparent" measure of the "sheltering error" of the standard at the wind velocities under notice. The slight increase in height of the central rod is a drawback, but of negligible amount.

As a matter of fact, the first form the writer had tried at Kew contained four equal additional cups, half the size of the regular cups, touching these but facing the reverse way.

The idea was to drive by the *difference* in pressure on the two sets of cups; and it will be seen, on calculation, that this duplex form offers a greatly increased resistance to "overrunning." Its motions were, however, described as "too erratic to allow of any useful comparison with the standard." On one occasion it turned backwards, like the dial of Ahaz. During this misbehaviour the standard kept strictly to the original motion.

It is, however, suggested, with due deference, that these abnormal motions ought not to be ascribed to the idiosyncrasy of the step form, but rather to the occurrence of small, sharp gyratory movements in the air, such as have been observed and described by the late Prof. Langley and others. In conclusion, it is suggested that the step form, having each cup freely exposed to the action of the wind, will get into its stride sooner than the standard; and that when "overrunning" (as the cups offer greater aggregate resistance) it will also sooner come to rest.

It was pointed out last month, by an eminent authority, that the step arrangement was not novel (as had been supposed), but had been adopted by the writer's old Professor, the late Sir G. G. Stokes, in a five-armed anemometer still in use at Holyhead. But, as this instrument is bridled, it does not revolve, and therefore the step arrangement and the fifth arm must have been introduced with some other object than that of diminishing the "sheltering error," which in the bridled form does not exist.

Ben Nevis Observatory.

In reply to a question recently put to him in the House of Commons by Mr. M'Crae, the member for Edinburgh East, as to whether he was in a position to say if he was able to accede to the request of the Scottish Members of Parliament for a grant to the Scottish Meteorological Society for the purpose of reopening and maintaining the Ben Nevis Observatories, the Chancellor of the Exchequer said the only scheme which had up to the present been placed before him was one under which the whole cost of the re-equipment and maintenance of the Observatories would be thrown upon public funds, and to this he did not feel justified in assenting. He was, however, quite prepared to consider the question of renewing the Government grant, which was for so many years given to these institutions through the Meteorological Council, provided that an adequate contribution towards their re-establishment and maintenance were forthcoming from other sources.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

May 15, 1907.

Ordinary Meeting.

Dr. Hugh Robert Mill, President, in the Chair.

Charles John Davis, Milford Haven;
Rev. William Esdaile, M.A., Burley, Ringwood;
Shaikh Abul Fazl, M.A., LL.D., Jullundher City, Punjaub, India;
Kimio Nishizawa, Tayek Iron Mine, Hupeh, China;
Robert Rhodes, Holmcroft, Kendal; and
Reginald Arthur Ryves, Assoc.M.Inst.C.E., Chepak, Madras, India,
were balloted for, and elected Fellows of the Society.

The President (Dr. H. R. Mill) said he regretted to see that the list of deaths included the name of Dr. R. Barnes of Eastbourne, a well-known Meteorologist, who had served on the Council of the Society. The death was also announced of the most eminent of British Meteorologists, Dr. Alexander Buchan, the first recipient of the Gold Medal of the Society, founded in memory of the late Mr. Symons. He need say little about the great work Dr. Buchan had accomplished in Meteorology, as it was brought fully before the Society only a few years ago. Dr. Buchan had lived remote from London, and his work had received less than justice in the obituary notices in the newspapers. He (the President) therefore thought it only right to place on record their recognition of the great part Dr. Buchan had taken in Meteorology. He had been for more than forty-five years the Secretary of the Scottish Meteorological Society, and had done much towards keeping the interest in Meteorology alive during the latter part of the last century. Dr. Buchan's writings filled perhaps the greater part of the *Journal* of his Society; he had taken the leading part in establishing the Meteorological Observatory on Ben Nevis in 1883, and was engaged in discussing and working up the results to the very end of his life. He had also done much towards stimulating the action of the Government with regard to the endowment of Meteorology, having helped towards securing the Committee of Inquiry into the working of the Meteorological Office in 1878, and the recent Treasury Committee which sat upon and abolished the Meteorological Council a few years ago. Dr. Buchan's *Handy Book of Meteorology* had done a great deal towards popularising the study of the subject. Chief among his other works was the fine series of Monthly Maps of Pressure and Temperature over the whole world, published in the *Challenger* Reports, and a series of detailed papers on the Climatology of the British Isles. He had also edited the Meteorological volume of Bartholomew's great *Physical Atlas*, which was founded upon and surpassed the famous Physical Atlas of Berghaus. He (Dr. Mill) had known Dr. Buchan for nearly twenty-five years as a friend and guide in matters meteorological. As a critic of observations and records he had a genius for lighting upon errors, and he had done the greatest service to hundreds of observers by teaching them the difficult lesson of their own fallibility. Dr. Buchan was less known in London than in Edinburgh, though for nearly twenty years he had been a member of the Meteorological Council. At home he had been the centre of a remarkable group of scientific men, and the dinners of the Royal Society Club of Edinburgh which he had arranged will never be forgotten by those privileged to take part in them. Dr.

Buchan was born in 1829, and his death would leave a blank in the ranks of meteorologists which would be felt, not in this country only, but throughout the scientific world.

The following communications were read :—

1. "THE BEST FORM OF RAIN GAUGE, WITH NOTES ON OTHER FORMS." By HUGH ROBERT MILL, D.Sc. (p. 265).

2. "ON A METHOD AND APPARATUS FOR MEASURING FOG DENSITIES." By J. W. LOVIBOND, F.R.Met.Soc. (p. 275).

3. "NOTE ON A BALLOON STRUCK BY LIGHTNING AT FARNBOROUGH, APRIL 11, 1907." By Col. J. E. Capper, R.E., C.B. (p. 279).

June 19, 1907.

Ordinary Meeting.

Dr. HUGH ROBERT MILL, President, in the Chair.

Lieut. JAMES BOYD ADAMS, R.N.R., 23 Versailles Road, Anerley, S.E.
Sir PHILIP LEE BROCKELHURST, Bart., Swythamley Park, Macclesfield ;
Capt. GEORGE S. CARY, Laurel Lodge, Terenure, Co. Dublin ;
HEDLEY CHAPMAN, 8 Old Jewry, E.C. ;
JAMES IRELAND CRAIG, M.A., Survey Department, Cairo, Egypt ;
Lord RONALD SUTHERLAND GOWER, Hammerfield, Penshurst ;
ERIC S. MARSHALL, M.R.C.S., 24 Willow Road, Hampstead, N.W. ;
ERNEST HENRY SHACKLETON, 14 South Learmonth Gardens, Edinburgh ;
FRANCIS RICHARD SHACKLETON, 44 Park Lane, W. ;
DOUGLAS SPENS STEUART, 8 Old Jewry, E.C. ; and
Sir ARTHUR VICARS, K.C.V.O., The Castle, Dublin,
were balloted for, and elected Fellows of the Society.

THE PRESIDENT (Dr. HUGH ROBERT MILL) said that before proceeding with the business of the Meeting he would like to make two announcements. The first was that the Annual Dinner of the Society had taken place at the Trocadero the previous night, and had been attended by a very good muster of Fellows, and also by a number of distinguished guests. The second announcement was, that in connection with the work of the Society he had been asked to attend before a Departmental Committee of the Board of Agriculture, and give evidence on the subject of Meteorology in Agricultural Education. This he had done, and had laid before the Committee the views of the Society on the importance of including Meteorology in the curriculum of the Agricultural Colleges. The suggestions had been cordially welcomed, and he had no doubt that they would receive full consideration.

The following communications were read :—

1. "WEATHER AND CROPS, 1891-1906." By FRANCIS CAMPBELL BAYARD LL.M., F.R.Met.Soc.

2. "THE RELATION OF THE RAINFALL TO THE DEPTH OF WATER IN A WELL AT CIRENCESTER, 1903-1906." By CHARLES P. HOOKER, F.R.C.P. (p. 287).

3. "THE STEP ANEMOMETER." By WALTER CHILD (p. 295).

DINNER OF THE ROYAL METEOROLOGICAL SOCIETY.

THE Annual Dinner of the Society was held at the Trocadero Restaurant on Tuesday evening, June 18, 1907. The President (Dr. H. R. MILL) was in the Chair, and the company included the following Fellows and guests:—

Mr. P. Y. Alexander
Mr. E. K. Allen
Major B. Baden-Powell
Capt. F. Bate
Mr. F. Campbell Bayard
Mr. R. Bentley
Mr. H. F. Bidder
Dr. W. P. Biden
Mr. L. C. W. Bonacina
Rev. H. A. Boys
Mr. A. H. Brown
Mr. E. S. Bruce
Sir Lauder Brunton, F.R.S.
Mr. A. E. Carey
Dr. C. Chree, F.R.S.
Capt. M. H. Clarke
Mr. R. Cross
Mr. J. A. Curtis
Mr. R. H. Curtis
Dr. H. N. Dickson
Mr. F. Druce
Mr. M. J. R. Dunstan
Sir T. Elliott, K.C.B.
Mr. W. Ellis, F.R.S.
Mr. P. C. Esdaile
Rev. W. Esdaile
Dr. R. Fortescue Fox
Mr. D. W. Freshfield
Rt. Hon. Sir G. T. Goldie, K.C.M.G., F.R.S.
Mr. W. V. Graham
Capt. G. Gregory
Mr. R. A. Gregory
Mr. R. T. Günther
Mr. H. Harries
Capt. M. W. C. Hepworth, C.B.
Mr. C. A. Hill
Mr. J. Hunter
Mr. R. Inwards
Dr. J. Scott Keltie
Major Bruce Kingsmill
Capt. W. P. Lapage
Mr. Baldwin Latham
Mr. R. G. K. Lempfert
Sir J. Norman Lockyer, K.C.B., F.R.S.
Mr. W. Marriott
Mr. W. J. Marriott
Sir R. B. Martin, Bart.
Mr. J. M. Maxfield
Mr. H. Mellish
Mr. R. Mond
Mr. R. W. Munro
Sir J. Murray, K.C.B., F.R.S.
His Excellency Dr. F. Nansen, G.C.V.O.
Mr. J. Percival
Prof. J. Perry, F.R.S.
Prof. Otto Pettersson
Sir R. Douglas Powell, Bart., K.C.V.O.
Hon. W. P. Reeves
Mr. C. Salter
Dr. R. H. Scott, F.R.S.
Mr. E. H. Shackleton
Dr. W. N. Shaw, F.R.S.
Mr. J. Wrench Towse
Mr. A. Vassall
Mr. S. G. Warner
Mr. A. Watt
Dr. C. Theodore Williams
Dr. R. W. Wilson
Capt. D. Wilson-Barker
Mr. H. D. Searles Wood
and Representatives of
The Daily Telegraph
The Morning Post
The Standard
The Times
The Tribune

THE PRESIDENT, in proposing the toast of "The King," said that it was a happy circumstance that in honouring the King they honoured also the most exalted meteorological observer in the Island and the Empire. His Majesty had expressed his personal interest in their science, not only in words but in deeds; for by his special command a rain gauge had been established at each of his residences, while at Balmoral His Majesty had recently set up a complete meteorological station.

THE PRESIDENT, in proposing the toast of "The Queen, the Prince of Wales (Patron of the Royal Meteorological Society), the Princess of Wales, and the other Members of the Royal Family," said that the Queen took a great interest in scientific instruments and in the welfare of the persons who used them. Many of those present would remember Her Majesty's visit to the *Discovery* before it sailed for the Antarctic regions. His Royal Highness the Prince of Wales, being a sailor, was also perforce a meteorologist.

His Excellency the Norwegian Minister, Dr. FRIDTJOF NANSEN, G.C.V.O., said that a great honour had been conferred on him in entrusting him with the toast of "The Royal Meteorological Society." He had to admit that it was with very great diffidence he proposed it, firstly because there were many people present who would be able to speak with far greater authority about the Society and meteorology than himself; and secondly he was afraid to speak about meteorology because most people had at the present moment, a grievance about meteorologists and the weather. Having observed that the Society was fifty-seven years old, Dr. Nansen said that the science with which it dealt was very young, and it was felt by all who knew anything about meteorology that they were only beginning to understand it. It was said by many that the golden aim of meteorology was to give weather forecasts and be of use, but the chief object of science was not to be of use but to promote the advancement of knowledge. All great steps forward in the history of humanity had always been taken by men who were desirous of more knowledge. He believed that meteorology, more than any other science, must be based upon the co-operation of men, because its means and methods were of a kind which no individual could ever master. Dr. Nansen went on to refer to the valuable work which had been done by the Society, and drew attention to its observations of the higher atmosphere by means of kites. He believed it was admitted by most meteorologists at the present time, that until they could obtain regular observations of the higher regions of the atmosphere, it would be very difficult to master meteorology proper. It had not been possible to get regular observations on the sea, but perhaps by the aid of wireless telegraphy they would be able to procure observations of the whole surface of the ocean. In his opinion the research work of the future would have to be done to a very great extent by the co-operation of Societies. He had no doubt that the Meteorological Office in this country, like the Meteorological Office he knew, had so much daily work to do that many important research problems could not be taken up to the extent that might be desired. He was sure they had a great future before them in dealing with the many questions connected with meteorology for the benefit of the science and of mankind.

The President, in reply, said if his Excellency the Norwegian Minister—whom he rejoiced to greet as an old friend—felt the responsibility of the toast almost too much for him, he himself found the duty of replying to it no less onerous. The Society was founded to promote study and research in meteorology, to encourage discussion, disseminate information, and to secure accurate observations with good instruments. Under a series of presidents—not a few of whom were happily present that evening—the Society had pursued its course, sometimes making new departures and more rapid progress, but always moving upward, and it was his good fortune to enter upon office at a time when the vigorous efforts of his immediate predecessors were beginning to have full effect in increasing numbers and efficiency. A few years ago Captain Wilson-Barker, giving evidence as President before a Government Committee, had been obliged to characterise the membership as being of the inauspicious number 666. Now it fairly exceeds 700, but they did not look on 7 as a perfect number in this respect, and he would not be satisfied until they counted a thousand active members. His successor, he hoped, might lead the Society to that degree of prosperity, and perhaps beyond it, for there were many thousand people in this country intelligently interested in the study of the weather. The weather, indeed, was the chief topic of conversation, and descriptions of it in the past, and especially in the future, occupied a considerable portion of the daily newspapers. There was a tendency amongst journalists to write humorously of the weather; he could not sympathise with that feeling, for to those who devoted their lives to its investigation, the weather of the British Isles was a very serious matter, and evoked more anxious thought than innocent hilarity.

The Society was now making several new departures. The sea of the atmosphere penetrated everywhere, touching all human interests on land and sea. They were pushing forward new lines of inquiry and enterprise, and although their plans were still to some extent in the air, he felt confident they would not dissolve into that element. It was difficult not to be discursive with such a theme, but he would court brevity, and refer only to two Committees of the Society. One of these was for the investigation of the upper atmosphere by means of kites and balloons, carrying recording instruments; this Committee, in connection with other Societies in this country, was taking part in the great international scheme for the investigation of the conditions and movements of the upper atmosphere in the Northern Hemisphere by means of kites and pilot balloons during the coming month. The other Committee he would refer to was the Local Scientific Societies Committee, which had for its work the dissemination of meteorological knowledge. The majority of the people of this country had not yet learned the alphabet of weather charts, and the Society was endeavouring, by means of Lectures, Exhibitions at conversaziones of Local Societies, and at great Shows like that of the Royal Agricultural Society which would be held at Lincoln next week, to familiarise the general public with the instruments and methods employed in observing and dealing with meteorological problems. This Committee was also trying to ascertain to what extent Meteorology was taught in schools and colleges, with a view to assisting in extending that instruction. He concurred with what Dr. Nansen said as to the great value of science combined with practical aims; it was the object of the Society to impress upon sailors, fishermen, and farmers the importance of meteorology in connection with their particular calling. There was a time, not so very long ago, when those who lived the open-air lives of sailor, fisherman, or farmer knew more about the signs of approaching change in the weather than any other class in the community. They were probably no less skilled now than in the past; but the advance of meteorological studies had revealed methods of forecasting weather far more accurate than those at the command of any non-instrumental observer; and the time had come when the fisherman and farmer who could not read and understand such publications as the Weekly and Daily Weather Reports should be convinced of the importance of learning to do so, and to profit by the new knowledge.

The Society was happy in its domestic arrangements. It had survived the shock of introducing Lady-Fellows. Its Council was in the closest touch with the Fellows, and on terms of perfect confidence; the staff was efficient and devoted. Mr. Marriott was almost the Society itself. The internal harmony was reflected in the fraternal relations which obtained with kindred institutions —relations which they hoped always to extend and improve. The Society had done well in the past, was hopeful for the future, and very happy in the present to hear such generous and stimulating words from their honoured guest.

Dr. C. THEODORE WILLIAMS, in proposing the toast of "Kindred Institutions," said he had felt disposed to speak freely; but after the shower they had just had in the shape of the song, "The Rain it raineth every Day," he would be more brief. Of all the institutions allied to Meteorology, that of the Royal Geographical Society seemed to appeal to outsiders as foremost. It was founded about 1830, although there were geographical institutions before that time, and since then it had become famous for the work it had done, for its publications, and for the researches and expeditions it had conducted. In fact the Society was a splendid piece of British enterprise, and he doubted if any other Society had done so much in all parts of the world for the advancement of knowledge. Its work at the Poles would specially be remembered, and they had present with them that evening the distinguished President of the Royal Geographical Society, Sir George Taubman Goldie, who was in every sense a true son of the Empire, the founder of Nigeria.

He thought, however, that he (Dr. Williams) must claim priority for the Royal Meteorological Society, as the effects of meteorological conditions, such as rain, frost, and wind, on the earth's primæval crust were the causes of geographical formations, and he therefore regarded the Royal Geographical Society as a daughter institute. They all admired the Society, and as it had a large following and ample funds, it was possible for it to accomplish much work, and the Royal Meteorological Society would be glad to follow its example if it had the available means. The Meteorological Office they were all proud of. It was in a very flourishing condition in spite of its small Government grant, which he thought ought to be doubled or even trebled. It was always advancing along new lines of progress, an instance of which was afforded in the annexation of Iceland to the daily weather charts. He did not know what the representatives of Denmark would have to say about such a procedure, but he hoped Dr. Shaw would be able to go still further, and even annex (only meteorologically of course) a little of the American Continent. He was sorry the Meteorological Office was leaving Victoria Street for South Kensington, but hoped it would be for convenience and more extended work. The Scottish Meteorological Society he would claim as a sister Society. It had done and was doing exceptionally good work, as their labours at Ben Nevis showed; and it was with deep regret that they had all recently heard of the death of Dr. Buchan, its ablest workman. The International Council of the North Sea he would also mention, and having crossed the North Sea many times in rough weather, he wished they could do something to improve its navigation and to smooth its terrors. With the British Association Committees, the Royal Meteorological Society had often worked together with agreeable results on kite and other investigations. The Solar Physics Observatory was making serious studies; but although the observatory was in London, they would not complain of having too much sunshine, and he was afraid that Sir Norman Lockyer was so fond of it that he had been accused of bottling it up instead of disseminating it over the country.

He had great pleasure in proposing the toast of the "Kindred Institutions," coupled with the names of the Right Honourable Sir George Taubman Goldie, President of the Royal Geographical Society, and Dr. Shaw, F.R.S., Director of the Meteorological Office.

The Right Hon. SIR GEORGE TAUBMAN GOLDIE, in reply, said he could not quite accept the relationship of mother and daughter between the Royal Meteorological Society and the Royal Geographical Society, and thought that sistership would perhaps express it better. He felt he was not addressing a rival audience that evening, for on looking around him he saw many representatives of leading geographical thought in this country, from whom he had learned much. His position, however, was not always so happy, as frequently he was heckled with questions, chiefly from educational authorities, such, as "What is geography?" His usual reply was by asking another question, as to whether they had ever read the opening paragraphs of "Geography" in the *Encyclopædia Britannica* written above the initials of H. R. M.? Referring to some of the remarks Dr. Williams had made, he stated that there were some deluded persons who thought that meteorology was only a branch of geography, while there were others who claimed that geography had no scientific basis at all. He was willing to grant to meteorology the air, provided that the earth and ocean were left to geography. Certainly meteorology played a great part in geography; the frosts by breaking up the surface of the rocks, the rains by filling the streams and rivers, and the winds by levelling forests, and all have an enormous effect upon the surface of the globe. But the surface of the globe had a great effect in determining the weather. He would only venture to offer one criticism and that was on the name of the Society, which presented considerable difficulties in pronunciation on the occasion of these annual mysteries. Why not come down from scientific Greek to the Latin word "Aerial," or on this halcyon evening to "Ariel" and "The Tempest."

Dr. W. N. **Shaw** added a few words in reply to the toast on behalf of those "Kindred Institutions" which were closely connected with the investigation of the air. The subject suggested a wide range of thought and a wide outlook. It included not only the Meteorological Office but also the Scottish Meteorological Society, the British Rainfall Organisation, the National Physical Laboratory, the Royal Observatory Greenwich, the Municipal Observatory of Southport, and the army of volunteer observers in various parts of the country to whom meteorology was greatly indebted. Neither could he limit the range to the institutions of Great Britain alone nor to the countries of Europe. Speaking in the presence of the Norwegian minister, for a subject of such international interest he wished that the duty of replying could have been undertaken by the doyen of professional meteorologists, Professor Mohn, the distinguished chief of the Norwegian Office, an ever-welcome member of international assemblies.

But reminiscences of distinguished meteorologists who were absent might occupy a long time. He referred to Dr. Buchan, whose recent death had been the subject of so much regret; to Sir Richard Strachey, who in another month would celebrate his ninetieth birthday; to Francis Galton, who was largely responsible for the scientific development of meteorology in days gone by and who was now in the later eighties; to Robert Scott, then present, who was looking at seventy years from the other side. The ranks of the older meteorologists were thinning rapidly—a circumstance which gave rise to feelings of much disquietude.

He recalled the Jubilee celebration of the Society in 1900, at which Dr. Williams had referred to meteorology as a delightful study which might be pursued in the country, and in one's absence carried on by a trusty gardener; on the same occasion Prof. J. J. Thomson had spoken of the formulation of definite questions for Nature to answer as the condition of progress in meteorological science. These were two aspects of meteorological work—observation and discussion. A third aspect was the dissemination of a knowledge of the subject among educated people. Knowledge was fruitless unless those for whom it was intended were instructed in the language in which it was written. As a primary condition for the diffusion of knowledge of this kind he had at various times appealed for the proper recognition of meteorology in the Universities, and with some success. Prof. Schuster had recently established a Readership in Dynamical Meteorology which would be filled at Cambridge by Mr. Gold of the Meteorological Office, who had recently carried out with marked success investigations on the relationship between the winds and the pressure of the atmosphere. The University of London had instituted a Readership in Meteorology, the only unfortunate drawback being the condition that the position should be filled by himself. By way of making a start towards a better state of affairs he had approached the Worshipful Company of Fishmongers as being marked out among the City Companies by their name for interest in meteorological science. They had responded with a liberal donation, for which he desired to make public acknowledgment.

For the kindred institutions he trusted that they were moving in the direction of more active co-operation, and that their forces might be so arranged that the greatest advancement of the science would result. In expressing this as the guiding principle of the work of the Office he spoke not only for himself, but for the staff by whom he was so loyally supported. He begged that any suggestion which came from the Office might be interpreted in the light of that principle.

Mr. RICHARD BENTLEY expressed the pleasure which had been given to every Fellow of the Society by the presence of so many distinguished guests at their annual gathering. The list of visitors indeed stretched from Pole to Pole, for they had amongst them Dr. Nansen from the North and Lieut. Shackleton from the South Pole, and they had also present the High Commissioner (Hon. H. Pember Reeves) of one of our great Colonies from the far distant Antipodes. Nearer home too they had the representatives of an important department of state, the Board of Agriculture and Fisheries; and of various scientific bodies, such as the learned Presidents of the Royal Geographical Society and of the Royal College of Physicians, the Chairman of the British Association Committee on Climate and Health (Sir T. Lauder Brunton), the Director of the Solar Physics Observatory (Sir Norman Lockyer), the President of the Physical Society, and the Chairman of the Royal Sanitary Institute, and they were surrounded on all sides by distinguished Fellows of the Royal Society. From abroad, too, they had Professor Pettersson, the Chairman of the International Council for the study of ocean problems; and as they met in London it was fitting that they should have at their table the heads of two of its ancient City Companies, Sir Richard Martin and Mr. Baldwin Latham. The presence of so many eminent guests was a striking, he might perhaps say a living, testimony to the greatly increased interest taken in recent years by men of thought in meteorology.

As we have noticed in the pages of history the rise in turn of different nations, so too have the arts and sciences come alternately to the front. In the lifetime of the last generation Literature, Painting, and Music held a foremost place, and a generation farther back Architecture. The present generation, however, lives in an era especially devoted to Science and research. But even among the Sciences themselves, where all are so closely related and all are making rapid advances, there are great variations in the limits of their respective conquests. Thus the geologist, though his dates may be sometimes open to discussion, has laid down for us certain fundamental laws we have to accept; the astronomer is sufficiently versed in the secrets of the universe to be able to predict even the path of a comet many hundreds of years in advance; the engineer knows beforehand the strengths and stresses of materials, or can calculate the speed of ships or range of guns even before they are built; and the chemist, like Mendeléeff, can predict not only the very existence, but also their exact position beforehand in the world of chemistry, of various missing elements or gases only to be discovered years afterwards, and then found to have been correctly placed in advance in their right place in series. But when we come to our own—might he call it inconstant—science of meteorology it is still more different. It is true that we have the knowledge of certain physical laws as a stepping-stone; but who, he would ask, even if endowed with the skill and training of a FitzRoy, a Scott, or a Shaw—who, he repeated, would be bold enough to attempt to forecast the weather of these islands a month—aye, or even for a fortnight—in advance?

Meteorology has already achieved much, and the immense national importance of the data collected by its trained observers for the safeguarding of the water supply of this country could be testified to, were it necessary, by no less an expert than the Chairman of the Metropolitan Water Board, who had intended being present that evening, or by other eminent engineers; while it was almost superfluous for him to touch on the value of the researches on climate and temperature in connection with health generally, but more especially in the cases of the fragile, and of the advanced invalid, in the presence of Sir Douglas Powell, of Sir Lauder Brunton, or of Dr. Theodore Williams. The relationship too between meteorology and agriculture had long occupied the attention of the Royal Meteorological Society, and at that moment further investigations were on foot to ascertain more precisely the influence of different phases of weather upon the various crops. Efforts too have been recently made to extend our system of forecasting by wresting from the upper atmosphere some of its unrevealed secrets, in course of which the envelope enfolding our globe has been probed for over fourteen miles upright overhead.

All this immense mass of work, of the greatest value alike to science and to the nation at large, has been carried on by the assistance of volunteers. Unlike in foreign countries, or even in some of our own dominions across the seas, so exiguous are the contributions of the State towards scientific research in England that much of this all-important work would have been delayed or even in some instances been left undone were it not for individual effort and initiative. At this time our learned President alone has a bodyguard of close upon four thousand picked and well-trained long-service men; and Mr. Mawley, Mr. Hopkinson, Mr. Bayard, and others each head regiments of select observers. Meteorologists may indeed feel very proud of an army numbered by thousands, all who serve in its ranks being animated by a common devotion to the cause of scientific research. The presence of so many strenuous and foremost workers in other paths of Science in their midst that evening would both add a fresh stimulus to the zeal and enthusiasm of these observers, and be an encouragement to them to pursue still further their attempts for the elucidation of the still unknown laws of the Higher Meteorology, the present mystery surrounding which attracts so many students in our direction.

Before raising their glasses to the coming toast, he would ask them to associate with it two representatives—of sea, and of land: in the first instance he would join with the toast the name of that veteran scientist Sir John Murray, who had generously devoted the labours of a lifetime to the exploration of the bed of the ocean—indeed he had heard it remarked that he was as much at home on the floor of the sea as Father Neptune himself!—or to fathoming the depths of the Scottish lakes, or to the solution of many problems of ocean life or currents, and who was also one of the founders of the observatory, now unhappily discontinued, on the summit of Ben Nevis; and with regard to land he would like to associate with the toast the name of Sir Thomas Elliott—of one who has spent so many untiring and successful years at the Board of Agriculture, bringing the application of that science in all parts of the country up to the level of the most recent investigations of the day—in converting, in short, the rule-of-thumb man of the type of Tennyson's "Northern Farmer" into a man of the Rothamstead type, a student of Lawes and Gilbert, up in all the latest improvements in machinery and manures and in modern modes of safeguarding crops against disease, etc., for with the increase of population it is now all important that the produce of agriculture should keep step with it and every acre of land possible be profitably utilised. He then gave the toast of "The Visitors," coupling with it the names of Sir John Murray and of Sir Thomas Elliott.

Sir JOHN MURRAY, in replying to the toast of "The Visitors," expressed his thanks for the kindly way in which the toast had been worded by Mr. Bentley. In the course of his connection with the Meteorological Societies he was convinced that they needed more financial support than other scientific societies. Their voluntary observers were scattered all over the country, and systematic observations were being carried on which would be of much value in providing material for future investigations. He thought the history of the Meteorological Societies illustrated the two great characteristics of the British nation, namely, the large amount of private and personal initiative and endeavour, and the equally large amount of Government indifference. He was sure they would all look forward to great development on the part of the

Society, as it was always a sign of a healthy condition when Annual Dinners were instituted.

Sir THOMAS ELLIOTT, in adding a few words, drew attention to the concluding musical item, "The long day closes," and could only imagine that Sir John Murray and himself were to play the part of the sunset. He would, however, leave the brightness of that phenomenon to Sir John. From his own knowledge of Meteorology he regarded it as an industrial science, but whether it was the handmaid or mistress of practice he could not say. Speaking of relationship, perhaps theirs of the Board of Agriculture and Fisheries to Meteorology was only that of a poor relation; but poor relations were not to be despised, and were sometimes of service. They were always ready to do what they could to help forward the cause of science. Mr. Reginald Hooker, in his recent paper on the "Correlation of the Weather and Crops," had inaugurated a new relation of Agriculture and Meteorology, and made it possible to say that some good had come out of Whitehall. The contribution of the State to scientific research, he was sorry to say, was always small.

Mr. F. CAMPBELL BAYARD then proposed the health of "The President." His reputation extended over the whole inhabited world, and was reflected upon the Society over which he was now presiding. He wished him every success.

THE PRESIDENT, in reply, said it was a great compliment to the success of the Dinner when yet another toast was added to the already lengthy list. He was afraid the proceedings would have been too protracted, but that was evidently not the general feeling. He much appreciated the kindly sentiment of the toast, and the honour of presiding over the Society.

Songs of an appropriate character were interspersed with the speeches, the musical arrangements being under the direction of Mr. H. Schartau. Among the songs were: "The stormy winds do blow"; "The rain it raineth every day"; "Haste ye soft winds to my relief"; and "The long day closeth."

CORRESPONDENCE AND NOTES.

Meteorology and Agriculture.

One of the most interesting features at the Royal Agricultural Society's Show held at Lincoln, June 25-29, was the Agricultural Education and Forestry Exhibition. In this the Royal Meteorological Society had an exhibit illustrating the work which the Society has recently undertaken for diffusing a knowledge of the science of Meteorology. The exhibit was attractively arranged, and was intended to bring home to those engaged in agricultural pursuits the desirability of systematically studying the weather. There was a large number of diagrams relating to rainfall, temperature, sunshine, the influence of weather on crops, health, etc., and also a fine collection of photographs illustrating meteorological phenomena. A fully equipped Climatological Station, with the various instruments in position, was set up in a railed-off enclosure, and Lectures were given by Mr. W. Marriott on "Meteorology in Relation to Agriculture." Various patterns of meteorological instruments were also shown, as well as specimens of lightning conductors, objects damaged by lightning, etc.

The County Councils' Association also arranged an interesting exhibition relating to rural education, showing samples of the work done by children in the schools. A Conference on the question of Nature Study in schools took place during the Show, when the following subjects were discussed: (1) "What is the aim of Nature Study in the rural school?" speaker, Mr. T. S. Dymond.

(2) "Is it advisable that children should be encouraged to make collections of natural objects in the light of the assertion that Nature Study leads to the despoiling of the neighbourhood?" Rev. A. Thorney. (3) "What is the system of school gardening which has the greatest value in rural education?" Mr. C. Turnor. (4) "That elementary Meteorology is a desirable subject for rural education," Mr. W. Marriott.

Official Appointments.

Meteorological Office, London—

Mr. Richard H. Curtis has been appointed Superintendent of the Instruments Branch, with which the Observatories Branch will be incorporated.

Mr. Richard Corless, B.A., Sidney-Sussex College, Cambridge, has been appointed Special Assistant to the Director.

Berlin, Königlich Preussischen Meteorologisches Institut—

Dr. G. Hellmann has been appointed Professor of Meteorology in the University of Berlin and Director of the Prussian Meteorological Service, in succession to the late Professor von Bezold.

Buenos Ayres, Oficina Meteorologica Argentina—

Mr. R. C. Mossman has been appointed Superintendent of Publications in the Argentine Meteorological Office. The appointment was made in October 1906, but Mr. Mossman was allowed a year in which to complete the meteorological and magnetical reports of the Scottish National Antarctic Expedition, which are now in the press.

Melbourne, Meteorological Bureau—

The Commonwealth Government has inaugurated a Meteorological Bureau at Melbourne, and has appointed Mr. H. A. Hunt, of the Sydney Observatory, as the Commonwealth Meteorologist.

Anticyclones as Aids to Long-Distance Forecasts.

Having recently read a paper before the South African Association for the Advancement of Science, upon "Anticyclones as Aids to Long-Distance Forecasts," I beg to place some of the leading facts before the Society. The paper is a continuation of one upon the progressive seasonal movements of anticyclones, which I read in London in July 1898, and which appears in the *Quarterly Journal of the Royal Meteorological Society*. I have been able to trace the same movements of the permanent anticyclones within the high-pressure belt of this hemisphere; and owing to the more stable atmospheric conditions which exist here, it has been possible to detect that the deviation northwards and southwards from a mean track is due to the belt itself having such a movement superposed upon its ordinary seasonal migration. Thus its range appears to be sometimes as much as 12° farther north than at other times. Within the belt the permanent anticyclones, whose headquarters in summer are over the Atlantic on the west side of South Africa, and as far away as the west coast of Australia on the east side, move to and fro according to the seasons. In winter they bring us very high pressure, and in some years they merge and form a core over the land. I pointed out these movements in 1898.

If the isobaric charts of recent years, beginning with Buchan's of 1868, are compared, great differences in the positions of the cores will be seen to exist. Moreover, if the percentage frequency of the winds in the several months, at such a station as Cape Town, is examined during different years, it will be found to vary, and to be related to these changes of position.

By an exhaustive analysis of the winds, barometric pressure, and other details since records were begun in 1841, the belt has been traced to have a cyclic movement from south to north and back again, with a period of about nineteen years; while the seasonal advance of the permanent systems composing the belt has varied concurrently, and in such a way as to result in a progressive displacement, from west to east, of the "centres of action" of the two systems when they met in winter. Instead of meeting on the west side of the continent in 1903, as they did in 1884, all the observations indicate that they were meeting over the sea to the east of Natal. Since 1903 the displacement, as it may be termed, has been from east to west.

The records are not sufficient to enable anything more than one passing from west to east to be traced, and this took about nineteen years. Mauritius and St. Helena observations, as well as all that are to be found in the observatories of Durban, Johannesburg, Kimberley, and Cape Town, have been made use of in the preparation of the paper, but care has been taken to point out that until synoptic charts become available these deductions must only be regarded as worthy of attention and nothing more. It would not be difficult, however, to put them to the test by examining the seasonal migration of the great northern high-pressure belt, which may reasonably be supposed to have a corresponding range northwards and southwards. The southern belt was in its extreme southerly position in the years 1884 and 1902-3, and in its most northerly in 1893. Some correspondence should be traceable in the breaking of the monsoons in India. Moreover, the displacement to an extreme easterly position in 1903 of the combined "centres of action" of the Atlantic and Australian systems must show some effect on, as well as some corresponding displacement of, the systems in the neighbourhood of India. Finally, the cyclic movement of the belt will introduce varying periodicities into the weather of places which are situated differently with respect to the belt, and to the positions occupied in successive years by the systems moving to and fro within it.—H. E. Rawson, Colonel, Pretoria, July 27, 1907.

The Thunderstorms of July 22, 1907, in Ireland.

Colonel Bentley, writing from Broadford, Co. Kerry, states that "there were two distinct thunderstorms on that date. The first, beginning at 3.30 p.m. and ending at 5.30 p.m., travelled from the south-east to the north-west, passing north of Broadford, where only a few drops of rain fell. The second began at 5 p.m. and lasted until 10 p.m., and travelled from south-west to north-east at right angles to the earlier storm. Only ·22 in. of rain was recorded at Broadford the next morning, but the drops were of considerable size, as the splash they made on the dry dusty road was about an inch and a half in diameter.

"Between the Kilbane hills and Killaloe, however, a tremendous fall of rain took place. It is only 4 miles between Kilbane and Killaloe by the mountain road, one mile of which is on the west side of the pass, and 3 miles are on the east of it. Five days later I walked over this road. Little rain had evidently fallen on the west of the pass, as the road here was barely washed clean. On the east side, however, the road was quite destroyed. Rifts were made in it 10 ft. deep, and at one place there was a gap torn out by the rush of water fully 30 ft. deep.

"Four times in half a mile was I driven to a circuitous progress over fields, as the cuts in the road were too wide and deep to surmount. Between the pass and Killaloe are two small streams. I had to ford both, as each of the bridges had been swept away. These rivulets are usually tiny ones, and I lifted my bicycle over without getting my feet wet. The first bridge of wood was carried away easily by the flood. The second was a large stone one (in a single arch) 25 feet high and 20 ft. wide. Nothing remained of it—the very foundations, on solid rock, were swept away. The oldest man resident near the spot never recalled such a rain or flood as there was on the 22nd. The hail, I was told, fell, not in the shape of round pebbles, but in large, rugged, irregular lumps of ice. The mountain side was flooded for 3 miles, and the farmers suffered much. The torrent burst into houses; and sheep, pigs, and crops were carried away by it. Fields of potatoes and turnips were washed bare. Near one of the streams a dead donkey, which had been carried down by the flood, hung in the fork of a tree 15 ft. above the ground.

"In a district measuring 3 miles long by one wide, six bridges (five of stone, and one of wood) were destroyed. The beds of the streams were completely removed, down to the hard rock. Near one of them had been a small wood of fine and ancient beech trees. Nearly all of these were torn up by the roots. It will cost the County Council close upon £3000 to repair roads and bridges, and the damage done to private property must amouut to nearly as much.—W. A. B."

Mr. C. H. Cooper, M.Inst.C.E., who was staying at the time in the neighbourhood of Carlow, reported that a heavy thunderstorm with hail occurred on the afternoon of July 22, and that damage was caused in Carlow and between Carlow and Bagenalstown. The hailstones were five-eighths of an inch in diameter, and were disc-shaped.

I went from Dublin to Cahir in Co. Tipperary on the same day, viz. Monday, July 22, and made some notes on the movements of the clouds, as it was one of the days specially set apart for the international observations of the upper atmosphere. They show how very disturbed the lower currents were, viz.:—

12.30 p.m. Limerick Junction. Alto-cumulus, W.S.W.
" " " Alto-stratus (drift), S.
3.30 p.m. Cahir. Cirrus, N.E.

This was evidently the summit of the clouds forming part of the thunderstorm over Carlow. I remarked at the time to Mr. R. W. Smith that this looked like a thunderstorm cloud, as it seemed to spread out from the top and to change very rapidly.

4.30 p.m. Tipperary. Cirro-cumulus, W.
4.45 p.m. Limerick Junction. Cirro-cumulus, S.
" " low cloud, E.
5.10 p.m. In train. Noticed scud drifting rapidly from N. This continued all the way to Dublin. Passed through a thunderstorm and showers. At one place the rain was running down the road in a sheet of water.

Evidently this was the storm referred to by Colonel Bentley, as at that time we were only a few miles to the eastward.—William Marriott.

Symons Gold Medal, 1908.

The Council of the Royal Meteorological Society have awarded the Symons Gold Medal for 1908 to Monsieur L. Teisserenc de Bort, of Paris, in recognition of the services which he has rendered to the science of Meteorology.

The Medal was established in memory of the late George James Symons, F.R.S., the founder of the British Rainfall Organisation, and is awarded biennially. The presentation will take place at the Annual General Meeting of the Society on January 15, 1908.

RECENT PUBLICATIONS.

British Rainfall, 1906. *On the Distribution of Rain in Space and Time over the British Isles during the year* 1906, *as recorded by more than* 4000 *Observers in Great Britain and Ireland, and discussed with Articles upon various branches of Rainfall work.* By HUGH ROBERT MILL. The forty-sixth annual volume. With Maps and Illustrations. 8vo. 280 pp. London, 1907.

The total number of complete rainfall records included in this volume is 4267, which is an increase of 171 over that for 1905. The greatest rainfall recorded at any station during the year was 205·30 ins. at Glaslyn, Snowdon, Carnarvonshire, and the least rainfall was 19·11 ins. at Boyton Rectory, Suffolk.

From a discussion of the general results it is shown that for Scotland as a whole the year was wet, the excess being 8 per cent over the 30 years' average 1870-99, which for that part of Great Britain coincided with the average of the ten years 1890-99. For Ireland the year was dry, the deficiency amounting to 6 per cent of the thirty years' average, or 5 per cent of the ten years' average 1890-99. For England and Wales there was a deficiency of 1 per cent on the thirty years' average, but an excess of 5 per cent on the much smaller average rainfall which prevailed for the ten years 1890-99. The integral parts of the British Isles therefore form a contrasted series, with England and Wales in the centre rejoicing in a rainfall which for the country as a whole was the average of thirty years, Scotland on the north with a very pronounced excess, and Ireland on the west with a scarcely less pronounced deficiency.

The frontispiece of the volume is a coloured map showing the variation of the rainfall of the British Isles in 1906 from the average of thirty years. By the use of deepening tints of blue for rainfall progressively more and more above the average, and deepening shades of red for rainfall more and more below the average, the wet and dry areas are made to stand out very clearly.

The volume contains two original articles, viz.:—(1) "The Christmas Snowstorm of 1906," by the Editor (8 pp.); and (2) "The effects of Exposure to Wind upon the amonnt of Rain caught by Rain Gauges, and the methods of protecting Rain Gauges from them," by L. C. W. Bonacina (19 pp.).

Dr. Schlich's Manual of Forestry. Vol. IV. *Forest Protection*, by W. R. FISHER, M.A. With 300 Illustrations. Second Edition. 8vo. London, 1907. 23 + 712 pp.

This work is an English adaptation of *Der Forstschutz* by Dr. Richard Hess, Professor of Forestry at the University of Giessen. It deals with the various aspects of Forest Protection, and gives some useful information respecting atmospheric influences on trees and plants, and suggests methods to be adopted for protection from injurious effects of frost, drought, wind, violent rain, hailstorms, snow, rime, etc.

Referring to the prevalence of hailstorms, the author makes the following statement: "These are sometimes very local, extending only over small areas. Thus, in Cambridgeshire, within fifteen miles round Chatteris, one shilling per acre insurance for agricultural crops against hail is charged; outside this zone, sixpence per acre." It would be very interesting to know why a higher premium is charged for this particular district. Is it really a fact that this zone has a larger number of hailstorms than occur elsewhere?

Notes on Maritime Meteorology. By M. W. CAMPBELL HEPWORTH, C.B., Commander R.N.R (Retired), Master Mariner. With seven Plates. 8vo. 90 pp. London, 1907.

The papers reprinted in this volume were contributed to various societies and institutions. They were compiled while the author was in active service afloat, partly for recreation and partly from a desire to contribute his iota to the cause of meteorology, and with the hope that the results of his investigations might prove of interest to his fellow-seamen.

The papers are :—

1. Meteorology : a Factor of Naval Warfare.
2. The Value of Meteorological Observations at Sea, and some Hints upon Observing.
3. Weather Forecasts and Storm Warnings on the Coast of South Africa.
4. Wind Systems and Trade Routes between the Cape of Good Hope and Australia.
5. The Tracks of Ocean Wind Systems in transit over Australasia.
6. Current Observations on the Canadian-Australian Route.
7. Remarks on the Weather Conditions of the Steamship Track between Fiji and Hawaii.

Observing and Forecasting the Weather: Meteorology without Instruments. By D. W. HORNER, F.R.Met.Soc. With Illustrations from Photographs taken by the Author. London, 1907. 8vo. 46 pp.

The object of the author in publishing this treatise has been that the ordinary individual may have a cheap and easily understood book by means of which he may quickly acquire some knowledge of the science of the weather, and become more or less expert at weather forecasting. As the author considers there are many works treating of instrumental observations, he has confined his remarks entirely to "non-instrumental observations," a subject which he considers can be taken up without any expense or outlay whatever by any one of average intelligence.

The subjects dealt with are "Clouds," "Wind," "Halos and kindred Phenomena," "Thunderstorms," "Weather Sayings," "The Moon and the Weather," and "Phenological Observations."

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INDEX.

Abnormal weather of the past summer, and some of its effects, 5
Absorption hygrometers, Errors of, 67
Adams (Lieut. J. B.), elected, 300
Address, Presidential, 81, 176
Adlercron (J. L.), elected, 178
Africa, Rainfall of, 4
——, Rainfall of South-West German, 200
Agriculture and Meteorology, 308
Air, The exploration of the, 193
Allerton (T. E.), Hailstorm at Charlestown, Natal, October 24, 1906, 181
Alps, The, as a weather-parting, 164
Alteration of By-law 15, 174
Anemometer, The "Step," 295
Annual General Meeting, 172
Antarctic, Meteorology in the, 164
Anticyclones as aids to long-distance forecasts, 309
Apparatus for measuring fog densities, 275
Appointments, Official, 57, 309
Atmosphere, Investigation of the upper, 254
Auditors, 56
Autumn and summer of 1768, 219

Baden-Powell (Major B. F. S.), elected, 252
————————————, The exploration of the air, 193
Badgley (Col. W. F.), Evaporation from the soil, 182
Baffin Bay, Ice and its movements in, 251
Balance sheet, 224
Baldwin-Wiseman (W. R.), elected, 56
Balloon struck by lightning, 279, 286
Balston (R. M.), elected, 56
Bebianno (D.), elected, 252
Bedfordshire, Destructive hailstorm in, August 2, 1906, 60
Beech trees and lightning, 66
Bell (C. L.), Obituary notice of, 237
Ben Nevis Observatory, 298
Bentley (R.), Weather in war time, 81
Bibby (Col. A.), elected, 172
Bilham (C. S.), elected. 172
Blackburn (J. A. P.), The storm areas of the globe, 57
Blue Hill Meteorological Observatory, 66
Bonacina (L. C. W.), Weather regarded as a function of climate, 213
Bradley (B. L.), elected, 172
British Islands, Temperature around the, in relation to the Gulf Stream, 207
Brockelhurst (Sir P. L.), elected, 300
Brussels, International Congress on Polar Exploration at, September 1906, 1
Bryant (W. W.), elected, 56
Buchan (Dr. A.), Death of, 299
Bureau Central Météorologique, Paris, 57
Burton (Col. H.), elected, 172
Butler (Hon. F. G. P.), elected, 56
Buyzer (C. A. O.), elected, 254
By-law 15, Alteration of, 174

Canada, Climate of the wheat area of Central, 55
Cape hailstorm, 171
Capper (Col. J. E.), Balloon struck by lightning, July 22, 1907, 286
——————————, Kites struck by lightning, July 10, 1907, 285
——————————, Note on a balloon struck by lightning, April 11, 1907, 279
Cary (Capt. G. S.), elected, 300
Chapman (H.), elected, 300
Charlestown, Natal, Hailstorm at, October 24, 1906, 181
Child (W.), The "Step" Anemometer, 295
Chowdry (K.), elected, 172
Christie (Sir W. H. M.), Meteorological work at the Royal Observatory, Greenwich, 1906, 182
Climate of Egypt, 257
———— Eritrea, North-East Africa, 274
———— Hebron, 71
———— the Niger Basin, 69
———— the wheat area of Central Canada, 55
————, Weather regarded as a function of, 213
Clouds, Measurement of the height of, by reflectors, 185
———, upper, Observations of, in New Zealand, 180
Club, Meteorological, 179
Correspondence and Notes, 57, 179, 254, 308
Council and Officers, 176
———, Report of the, 172, 221
Craig (J. I.), elected, 300
Crocker (E. G.), elected, 172
Cross (R. T. G.), elected, 252

Daily Weather Report, 184

Davis (C. J.), elected, 299
Delanasau, Fiji, Rainfall at, 1906, 205
Derry (G. T.), elected, 178
Desert, Mirage in the, 212
Destructive hailstorm in Bedfordshire, August 2, 1906, 60
Digby (Capt. K. E.), elected, 56
Dinner of the Royal Meteorological Society, 301
Display of phosphorescence, 294
Donations, 242
Donnellan (B. J.), elected, 252
Drought in 1906, Effect of, 70
Dynamical meteorology, Readership in, 188

Effect of drought in 1906, 70
——— the March 1907 sunshine, 211
Effects of the wind upon railways, 200
Egypt, Climate of, 257
Elliot (Major G. R.), elected, 56
Eritrea, Climate of, 274
Errors of absorption hygrometers, 67
Esdaile (Rev. W.), elected, 299
Etti (Capt. C.), elected, 172
Evaporation from the soil, 182
Exploration of the air, 193

Falcon (R.), elected, 172
Fazl (S. A.), elected, 299
Fiji, Rainfall in, 201, 205
Finnemore (R. I.), Obituary notice of, 238
Flickering lightning, 293
Fog densities, Method and apparatus for measuring, 275
Forecasts, Anticyclones as aids to long-distance, 309
Formation of hailstones, 186
Forrester (J. W.), elected auditor, 56
Freshfield (D. W.), elected, 254

Galbraith (Major G. E.), elected, 56
Galloway (Capt. A. A.), elected, 56
George (W. C.), elected, 172
German South-West Africa, Rainfall of, 200
Gibbs (J. R.), elected, 56
Gibson (H. T.), elected, 172
Gidley (H. J. W.), elected, 56
Gilbert (E. O.), elected, 172
Goss (W. H.), Obituary notice of, 239
Gower (Lord R. S.), elected, 300
Green (G. A.), elected, 252
Greenwich, Meteorological work at the Royal Observatory, 1906, 182
Greenwood (Capt. W. N.), Obituary notice of, 240
Guildford storm of August 2, 1906, 41
Gulf Stream, Temperature around the British Islands in relation to the, 207
Gunn (Dr. J. St. C.), Observations of upper clouds in New Zealand, 180

Hailstones, Formation of, 186
———, Structure of, 63
———, Suggestions to observers of, 65
Hailstorm, A Cape, 171
——— at Charlestown, Natal, October 25, 1906, 181
Hailstorm at Lewisham, June 25, 1652, 65
——— in Bedfordshire, August 2, 1906, 60
Hebron, Climate of, 71
Height of clouds, Measurement of, 185
Hill (J. E. H.), elected, 254
Hipwell (H. W.), elected, 252
Hoar frost at high altitudes, 261
Hoffmann (J. W.), elected, 56
Holmes (R. L.), Phenomenal rainfall in Suva, Fiji, August 8, 1906, 201
———, Rainfall at Delanasau, Bua, Fiji, 1906, 205
Hong-Kong typhoon of September 18, 1906, 212
Hooker (C. P.), The relation of the rainfall to the depth of water in a well, 287
Hot sunshine causes a railway accident, 212
Howard Medal, 1906, Meteorological essay for, 57
Hygrometers, Errors of absorption, 67

Ice and its movements in Baffin Bay, 251
Indian rainfall and its result, An, 270
Insolation of Switzerland, 68
Inspection of stations, 231
Installation of new President and Secretary, 177
International Congress on Polar Exploration, September 1906, 1
Investigation of the upper atmosphere, 254
Inwards (R.), The metric system in meteorology, 165
Ireland, Thunderstorms of July 22, 1907, in, 310

Jones (W. A. M.), elected, 178

Keane (Capt. G. M.), elected, 178
Kingdon (H. F.), elected, 172
Kingsmill (Major J. B.), elected, 252
Kitchen (E. W.), elected, 56
Kite observation fund, 1906, 228
Kites struck by lightning, July 10, 1907, 285
Klondike, Rain-making experiments in the, 199

Lane (Mrs. M.), elected, 56
Lane (W. C.), elected, 254
Lantern slides, 242, 251
Le Cocq (Gen. H.), elected, 172
Lecture, 193, 252
Lectures on meteorology, 57, 179, 308
Lewisham, Hailstorm at, June 25, 1652, 65
Life composition, Alteration of, 174
Lightning and beech trees, 66
——— and trees, 66, 255
———, Balloon struck by, 279, 286
——— conductors, Exhibition case of, 251
———, Flickering, 293
———, Kites struck by, 285

Literature, Meteorological, 77, 190, 261, 313
Local Scientific Societies' Fund, 1906, 228
Lovibond (J. W.), elected, 172
———, On a method and apparatus for measuring fog densities, 275
Lynch (Capt. C. W. D.), elected, 254

M'Ewan (J.), elected, 178
Maclear (Admiral J. P.), Beech trees and lightning, 66
———, The Guildford storm of August 2, 1906, 41
Mallins (C. W.), elected, 172
Manners (Capt. C. G. E. J.), elected, 56
Mansergh (E. L.), elected, 252
Mansergh (W. L.), elected, 252
Marriott (W.), Inspection of stations, 231
———, Presentation to, 173
———, The abnormal weather of the past summer and some of its effects, 5
Marshall (E. S.), elected, 300
Mawley (E.), Report on the phenological observations, 1906, 139
Measurement of the height of clouds by reflectors, 185
Meetings, Proceedings at the, 56, 172, 252, 299
Mellish (H.), elected Secretary, 177
Meteorological Club, 179
——— Essay for the Howard Medal 1906, 57
——— literature, 77, 190, 261, 313
——— Observatory, Blue Hill, Mass., U.S.A., 66
——— work at the Royal Observatory, Greenwich, 1906, 182
——— work at the Radcliffe Observatory, Oxford, 1906, 184
Meteorology and agriculture, 308
———, Readership in dynamical, 188
——— in the Antarctic, 164
———, Lectures on, 57, 179, 308
———, Metric system in, 165
Method and apparatus for measuring fog densities, 275
Metric system in meteorology, 165
Miles (L.), elected, 172
Mill (H. R.), elected President, 176
———, The best form of rain gauge, with notes on other forms, 265
———, The International Congress on Polar Exploration at Brussels, September, 1906, 1
Mill (Mrs. H. R.), elected, 56
Mirage in the desert, 212
Mond (R. L.), elected, 56
Montagu of Beaulieu (Lord), elected, 172
Morgan (M.), elected, 172
Mudd (A.), elected, 178

Netherlands, Meteorological Institute, 57
Newman (T. P.), elected auditor, 56
New Premises fund, 226
New Zealand, Observations of upper clouds in, 180
Niger Basin, Climate of the, 69
Nishizawa (K.), elected, 299
Note on a balloon struck by lightning, 279, 286
Notes and Correspondence, 57, 179, 254, 308
Nursey (R.), elected, 178

Obituary notices, 237
Observations of upper clouds in New Zealand, 180
Officers and Council, 176
Official appointments, 57, 309
Ogden (A. B.), elected, 178
Optical Society, 3
Oxford, Radcliffe Observatory, Meteorological work at, 184

Paris, Bureau Central Météorologique, 57
Parkinson (C. L. J. M.), elected, 56
Peacock (Capt. S. C.), elected, 254
Pearson (E. J.) Obituary notice, 241
Peters (Major C. W.), elected, 56
Phenological observations, 1906, 139
Phenomenal rainfall in Suva, Fiji, August 8, 1906, 201
Phosphorescence, Display of, 294
Photographs, 250
Polar Exploration, International Congress on, 1
Port-au-Prince, Société Astronomique et Météorologique, 185
Powell (H. J. B.), elected, 56
Presidential address, 81, 176
Presentation to Mr. W. Marriott, 173
Proceedings at the meetings, 56, 172, 252, 299
Propert (Dr. W. P.), Obituary notice of, 241
Publications, Recent, 73, 188, 312
Purchases, 242

Railway accident, Hot sunshine causes a, 212
Railways, Effect of wind upon, 200
Rainfall, An Indian, and its result, 70
——— at Delanasau, Bua, Fiji, 1906, 205
——— of Africa, 4
——— of German South-West Africa, 200
———, Phenomenal, in Suva, Fiji, August 8, 1906, 201
———, Relation of, to depth of water in a well, 287
Rain gauge, Best form of, 265
Rain-making experiments in the Klondike, 199
Rambaut (A.A.), Meteorological work at the Radcliffe Observatory, Oxford, 1906, 184
Rawson (Col. H. E.), Anticyclones as aids for long-distance forecasts, 309
Read (H.), elected, 56
Readership in dynamical meteorology, 188
Recent publications, 73, 188, 312
Report of the Council, 172, 221
——— on the phenological observations, 1906, 139
Research fund, 226

Rhodes (R.), elected, 299
Richardson (D. L.), elected, 172
Ryves (R. A.), elected, 299

Scrutineers, 172
Shackleton (E. H.), elected, 300
Shackleton (F. R.), elected, 300
Shafi (S. M.), elected, 254
Sibthorpe (Col. F. R. W.), Obituary notice of, 242
Slade (Capt. E. J. W.), elected, 56
Smith (E. S. A.), elected, 172
Société Astronomique et Météorologique de Port-au-Prince, 185
Soil, Evaporation from the, 182
Sowerby (W.), Obituary notice of, 242
Stations, Inspection of, 231
"Step" anemometer, 295
Steuart (D. S.), elected, 300
Storm areas of the globe, 57
——, The Guildford, of August 2, 1906, 41
Strachan (R.), Temperature around the British Islands in relation to the Gulf Stream, 207
Structure of hailstones, 63
Suggestions to observers of hailstones, 65
Summer and autumn of 1768, 219
———, The abnormal weather of the past, 5
Sunshine, Hot, causes a railway accident, 212
———, March 1907, Effects of, 211
Suva, Fiji, Phenomenal rainfall in, August 8, 1906, 201
Switzerland, Insolation of, 68
Symons Medal, 228, 311

Temperature around the British Islands in relation to the Gulf Stream, 207
Thunderstorms of July 22, 1907, in Ireland, 310
Trees and lightning, 66, 255
Turner (J.), elected, 254
Tuxford (A. S.), elected, 56
Typhoon of September 18, 1906, The Hong-Kong, 212
Tyrwhitt (T.), elected, 254

Upper atmosphere, Investigation of, 254
Upsala Meteorological Observatory, 57

Vidyabhusan (P. G. M.), elected, 252

War-time, weather in, 81
Warren (P. D.), elected, 254
Water in a well, Relation of rainfall to the depth of, 287
Weather in war-time, 81
——— of the past summer, and some of its effects, The abnormal, 5
——— parting, The Alps as a, 164
——— regarded as a function of climate, 213
Wellington (New Zealand) and wind, 70
Wheat area of Central Canada, Climate of, 55
Wilson (W.), elected, 56
Wind upon railways, Effects of, 200
Wyndham (Hon. H. A.), elected, 56

Zambra (M. W.), elected, 172

THE END OF VOLUME XXXIII.

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